BONES OF COMPLEXITY

Bioarchaeological Case Studies of Social Organization and Skeletal Biology

Edited by Haagen D. Klaus, Amanda R. Harvey, and Mark N. Cohen

Bones of Complexity

Bioarchaeological Interpretations of the Human Past: Local, Regional, and Global Perspectives

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Foreword by Clark Spencer Larsen

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FOREWORD

This volume is among the first to explore the complexity of and linkages between social organization and human biology through the study of human remains recovered from archaeological contexts in settings from both the New World and the Old World. Paramount in these considerations is the role that inequality and access to resources plays in health and well-being. Because of the remarkable reservoir of knowledge human remains contain about living conditions during life, the strength of the book is its contribution to the discussion regarding health, social structure, and economic inequality in anthropology and other social and behavioral sciences. This book is not the first to explore social complexity, but it is the first to explicitly orient an edited volume around the topic. Importantly, the book has relevance to global issues today, especially regarding the outcomes and consequences of social inequality. The contributors make clear that the broad spatial and temporal context of bioarchaeology provides important insights into the origins and evolution of inequality and its profound impact on peoples' lives.

It is clear from my reading of the book that the editors gave the authors a roadmap for presenting their research, especially with regard to focus on the themes of the book, clear presentation of the aims for each chapter, and attention to the core issues. The editors and contributors are less focused on "why, when, and how complexity developed in human history" and instead seek to shed light on how social and economic structures, at varying scales of complexity and in diverse global cultures, have shaped human health. These are issues of central interest to bioarchaeologists, archaeologists, and those interested in human biology. Klaus, Harvey, and Cohen's introductory chapter provides a concise overview of terms and theoretical concepts relevant to the field and demonstrate how skeletons provide a fund of data for understanding inequality.

Some of the chapters revisit earlier problems from an iconic region and earlier investigations of such regions. For example, the bioarchaeological community is very familiar with William Haviland's (1967) classic study of stature and status at the Maya community and ritual nucleus at Tikal. His work was among the first to show the outcome of social inequality and differential access to resources that directly impact peoples' lives. We now know that the elites there had better diets and better access to quality nutrition and that this enabled them reach their potential heights. In contrast, non-elites lacked the resources needed to grow to their full genetic potential. Wright and Vásquez's revisitation of Haviland's study of stature and status at Tikal demonstrates how far bioarchaeology has come and how it is possible (and strongly encouraged) in this field and in other sciences to test and retest earlier hypotheses. These advances are of course theoretical, but the tools at hand (such as stable isotope analysis) were not even dreamed of a half-century ago and provide new means of addressing old problems. Various contributors to the volume address the topic of stature. I am especially struck with how much we know about terminal height and the complexity of behavioral and other factors that influence it. I am also struck by just how much more we need to know before drawing simple conclusions based largely on old models and limited understandings of the biology of growth and development.

In addition to the superb introduction, the editors provide an excellent concluding chapter that brings the reader back to what we have learned about life conditions, well-being, and future questions and agendas for the study of biological outcomes of complexity. Unlike many edited volumes, the editors have provided the reader with a book that has both a strong introduction that lays out the issues and a strong conclusion that reminds us of how far the field has come in understanding the biological signature of social complexity but also of the limitations that need to be addressed if the field is expected to advance.

The authors collectively make clear that social inequality and the complex landscape it implies does not pertain to just access to differential resources. Rather, they make the case that bioarchaeology is positioned to address social organization, a strength in the field of anthropology in general but one that has perhaps less "buy-in" in subdisciplines that do not have a history of engagement (e.g., bioarchaeology). The reader of this volume will see that understanding social organization and complexity are essential elements to frame research involving the study of the human condition. The bioarchaeological record provides both a robust temporal and spatial con-

text for the fund of data provided by the study of human skeletal remains and a wider context from which to understand the origins of the modern world and how the social inequality that is widespread in the world today has ancient origins.

Clark Spencer Larsen
Series Editor

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The concept for this volume originally emerged several years ago following the publication of *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification*, edited by Mark Cohen and Gillian Crane-Kramer (University Press of Florida, 2007). In many ways, that book was a direct descendant of the highly influential 1984 volume, *Paleopathology at the Origins of Agriculture*, edited by Mark Cohen and George J. Armelagos (University Press of Florida). One of the many productive issues arising from the lineage of both collections involved new questions about the many potential entanglements between human biology, social organization, and economy. This volume joins the other two, forming a trilogy of sorts, and continues to explore fundamental issues in bioarchaeology, culture, and human biology. The development of this book has been long and complex. We sincerely thank the many contributors for their commitment to this project as it evolved over the last few years and moved toward publication.

Upon Mark's retirement, the future of this volume became unclear. Haagen and Amanda were recruited in late 2012 to take the book across the finish line. They both sincerely thank Mark for the depth of trust he placed in them to complete this book. We also thank series editor Clark Larsen for his unfailing guidance and support in this process. At George Mason University, we thank Amy Best, Andy Bickford, Deborah Boehm-Davis, Les Kurtz, and Dan Temple. Also, special thanks are due to Richard Scott (University of Nevada, Reno) and Marie Danforth (University of Southern Mississippi) for their comments and thoughts throughout the editorial and production processes.

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Human Biology in Ancient Complex Societies

Some Concepts for Bioarchaeology

HAAGEN D. KLAUS, AMANDA R. HARVEY, AND MARK N. COHEN

Over the last 400 generations or so, a number of unprecedented behavioral transitions have occurred. A few in particular have no comparable analogs in the previous seven million years of *Hominidae* and were so transformative that their legacies and ongoing expressions directly structure our modern world. Specifically, the histories of many human societies over the last ten millennia have been characterized by increasing social complexity and economic inequality that is found in the appearance and growth of stratified, territorial, and sedentary societies whose subsistence economies were based on large-scale domestication of plants and animals. The anthropological search to understand the reasons, processes, and consequences of these changes has led to some of the most fundamental and important questions that have ever been posed in the study of human history, biology, and behavior.

This book brings together studies by physical anthropologists, archaeologists, and economists that attempt to provide snapshots across time and space in order to better understand the potential effects of social complexity on human biology in the past. The authors are less focused on questions about the origins of social complexity than they are on a range of historical, archaeological, and biological questions related to the entanglements between sociopolitical organization, economic variation, and inequality in specific times and places in Europe, northern Africa, Asia, and the Americas.

The Bioarchaeology of Complexity: Conceptual and Theoretical Grounds

The modern archaeological study of social complexity is broadly concerned with the development of hierarchical formations of social, political, and economic structures such that management of labor and production is functionally beyond the control of a household or immediate kin group (Arnold 1996). The concept of "complex society" generally relegates the complexity of linguistic, artistic, or cosmological systems to a marginal status. Instead, social complexity has long been glossed in archaeological thinking as a phenomenon expressed in socioeconomic and political terms (Hayden 2014). Roots of such thinking are found in the typological and nomothetic visions of Lewis Henry Morgan and Edward Tylor in the nineteenth century and in the cultural ecology and neoevolutionary approaches of Julian Steward and Leslie White in the mid-twentieth century. Even today, the origins, variability, and consequences of social complexity are some of the biggest questions we can explore regarding history, social change, and human nature. Perhaps another reason for such persistence of this research theme involves a desire for reflexive commentary about social inequality, one of the "facts" of modern Western society (Lauguens 2014; McGuire and Saitta 1998; Tainter 1990).

Many scholars in the anthropological tradition have contemplated the evolution of social complexity, including Childe (1951), Stewart (1955), Fried (1967), Flannery (1972), Plog (1974), Service (1975), Cohen and Armelagos (1984), Johnson and Earle (1987), Price and Feinman (1995), Boguki (1999), Boehm (1999), and Yoffee (2005). Studies of complexity have been often been entwined in the cultural discourses of their day, such as the social evolutionism of the nineteenth and early twentieth centuries, the positivist and teleological emphases of early processual archaeology, and the postmodern historiographic conceptions of the *longue durée* of the Annales School (for further discussion, see Trigger 1999 and Yoffee 2005). In U.S. archaeology, work explicitly concerned with social complexity seems to have found one peak within processual archaeology in the latter half of the twentieth century, but recently new foci have emerged, inspired by comparative empirical approaches, evolutionary theory, and postmodern social theory (e.g., Smith 2012; Whiten et al. 2012; Yoffee 2005). Other recent discussions (e.g., Flannery and Marcus 2012), eschew explicit theorization and gravitate toward pattern-seeking approaches oriented in terms of contemporary social concerns. Today, a good number of archaeologists,

at least in our circles, tend to be wary of or avoid evolutionary typological labels such as "chiefdoms" or "states" in the wake of the critique of positivist and neoevolutionary conceptions. Yet the concepts, definitions, and comparative characteristics of a band, chiefdom, or state are notions within studies of social complexity that eventually come full circle and often must be confronted one way or another.

Archaeologists have employed diverse methods and measures to characterize complexity over the last century. These include: 1) settlement patterns, including estimations of community size and degrees of population nucleation; 2) mortuary patterns; 3) comparative distribution of utilitarian and high-value or exotic goods; 4) development of regional and centralized economic systems with internally specialized mechanisms; 5) centralization of religious and leadership systems; 5) size, differentiation, labor investment, and quality of construction materials used in built spaces from corporate architecture to sites of craft production, domestic occupation, and cemeteries, and; 6) cultural constructions of landscapes and territory.

Of all the possible lines of evidence, human remains are newcomers to this area of study. This may seem paradoxical, as skeletal remains probably represent the most information-dense form of any archaeological material (Gowland and Knüsel 2006). Due to the development of bioarchaeological science over the last four decades, human bones and teeth today impart increasingly compelling understandings of the interplays between biology and behavior (e.g., Larsen 2015) and shed new light on core anthropological questions about the nature, development, and consequences of social complexity and inequality.

The bioarchaeology of social complexity can be a fundamentally social or contextual form of bioarchaeology (Agarwal and Glencross 2011). Especially for these types of questions, skeletons cannot be analyzed in a vacuum: researchers must engage with archaeological data and theory. Otherwise, the bioarchaeology of social complexity is devoid of purpose and becomes an exercise in counting lesions. In other words, a bioarchaeology of social complexity depends on the degree to which researchers integrate archaeological data and other forms of contextual information with their findings. Since a contextual bioarchaeology of social complexity and inequality requires conceptual and theoretical grounding in broader archaeological frameworks, the following section discusses a few relevant concepts, issues, processes, caveats, and opportunities—with interpretive bioarchaeology and behavioral impacts on skeletal biology directly in mind.

Roots of Early Social Complexity

Why, when, and how social complexity developed in human history is, to us, a profound intellectual and scientific question. The causes of increasing social heterogeneity have been debated for over a century, developing from social evolutionary typologies to neoevolutionary thinking and more recent critiques that provide fresh perspectives (e.g., Yoffee 2005). Our purpose here is not to summarize the evidence or weigh competing models of the origins of social complexity but to touch on some thoughts that have potentially meaningful bioarchaeological implications.

Considering that the last common ancestor shared by chimpanzees and hominins was probably behaviorally more akin to chimpanzees than modern humans, it is likely that the origins of human beings lie among rather hierarchical apes. Egalitarianism, which is so often assumed to be an innate quality of ancestral hunting and foraging lifestyles, was a novel form of social organization that had to develop at some point in human history (Boehm 1999). Furthermore, it has been understood since the 1960s (Lee and DeVore 1968) that hunter-gatherers are very complex people indeed (Cumming et al. 2014). The study of social complexity cannot be skewed just toward the study of large social systems, and we further elaborate on this point in the concluding chapter of the volume.

Beginning some 2 million years ago, various hominins engaged in a sequence of migrations out of our African homeland. Ethnographic analogies (Lane 2014) have long been used to suggest that these foragers and scavengers and, much later, hunters, existed in social groups comparable in size and structure to modern analogs. The multiple transitions from this form of social structure and subsistence economy began some 12,000 years ago from unique confluences of ecological factors, preexisting social asymmetries, new technologies, and new manners of food production. Still, fundamental questions surround the specific timing of these transitions (which began only some twelve millennia ago), their geographical and ecological distributions, the role of demography, the nature of the preceding foraging economy and society, and the applicability of push, pull, or social models (e.g., Hayden 1992; Flannery 1969; Stark 1986) for the various origins of sedentary food-producing societies.

For most of the last 40,000 years, many different kinds of hunter-gatherers demonstrated signs of social differences and inequalities through the distribution of prestige goods, changes in mortuary patterns, and subsistence technologies (Hayden 2014; Nillson Stutz 2014) that established

the groundwork for more complex forms of culture and food production. Flannery and Marcus (2012), who link their global survey of archaeological trends to ethnohistoric and ethnographic perspectives, think that the first steps toward hierarchical social organization was completely unintended and was rooted in the Pleistocene era as larger social units (i.e., clans) emerged. From there, similar trends toward increasing complexity were initiated in many (but not all) human societies that took these steps (Boguki 1999; various chapters in Smith 2012). Such changes notionally promoted the emergence of hereditary rank to culminate (so far) with nation-states.

Flannery and Marcus (2012) also posit that the roots of inequality were neither common nor inevitable but that strong structural asymmetries nonetheless have emerged independently over the last 10,000 years. Perceived differences in life force, virtue, intellect, generosity, debt, and prowess in combat connected achievement-based systems of social organization to formulations of hereditary rank in varied ways. Price and Bar-Yosef (2010) reflect on the possibility that the rise of agriculture coincided with the creation of status differentiation linked to emergence of surplus foods in the Near East. Along these lines, varying access to and control of food or arable land appear to be another major factor in the establishment of gradients of social rank. Sex, age, and other unique skill sets that have economic bases can also sow seeds of emergent inequalities (Flannery and Marcus 2012; Hayden 1995).

As short-term camps gave way to multi-generational, achievement-based villages, cultivation of wild plants intensified, food surplus increased, and wild animals were domesticated. As sedentary subsistence economies strengthened, ceremonial customs transformed from small-scale supplications into ancestor veneration rituals. "Men's houses" developed into ritual houses and restricted-access temples. Ritual knowledge, too, became increasingly exclusive under the purview of ritual specialists. Conflict became all too frequent and was harnessed as a tool for the aggrandizement of chiefs (Flannery and Marcus 2012). One may ponder to what degree existing bioarchaeological evidence of intergroup violence at pre-agricultural sites such as Jebel Sahabah in Egypt (Wendorf 1968), Neolithic Europe (Schulting and Fibiger 2012), and elsewhere reflect the role of violence in this broader process.

Archaeological evidence indicates that long-term trends of increasing social diversity have been generally irreversible over large regions. However, this broad pattern probably emerged from many oscillations between

cycles of increasing and decreasing complexity (Schwartz and Nichols 2006). Still, increasing fertility leading to greater population sizes tend to require, in a very practical sense, progressively intricate socioeconomic and political systems to manage or manipulate them (e.g., Carneiro 1981, 1991). Competition among different constituent polities, increasing sizes of central places and their associated hinterlands, and the magnification of subsistence economies seem to be widely recognizable cross-cultural effects of growing social heterogeneity.

Some Theoretical and Structural Characteristics of Complexity

Complex societies may be broadly characterized as having two basic organizational features: hierarchy and heterarchy. They are not mutually exclusive or fixed features of a society. On the contrary, their inherent mutability creates great dynamism in social interactions. Theoretically, an embedded habitus of difference may strengthen and reify these two components of social inequality (Bourdieu 1977; Jenkins 1992; Joyce 2000; Silliman 2001). Communal habitus serves to reproduce cultural norms and perpetuate the status quo or stability of social complexity. However, at the same time, an embedded habitus may be constantly manipulated to serve as a force of social change as agency gives both individuals and groups the power to challenge it.

These features may lend to the formation of certain frictions stemming from the coexistence of forces and factors that seek to maintain the social status quo, while at the same time other elements are attempting to challenge and transform the nature of society. Flannery and Marcus (2012, 563) also remark on how the escalation of inequality and entrenchment of power among progressively fewer people requires elites to overcome resistance. This is the tension between those who desire to be superior and those whose interests and agendas are overpowered in the process. These forces shape collective patterns of human behavior and, accordingly, aspects of skeletal biology as well (Goodman 2013), whether it be subtle variations in access to resources and nutritional status, physical activity patterns reflected in the ontogeny of long-bone cross-sectional geometry, or traumatic skeletal injuries produced by violent conflicts.

Hierarchy

Hierarchy, or vertical differentiation, involves rank stratification and asymmetrical, status-based distributions of power, resources, and privilege (e.g., Fried 1967). Hierarchy is probably the most bioarchaeologically accessible

feature of a ranked society. Vertical social differentiation may be measured in many ways, including ranked gradations of social status, centralization, and access to resources.

Any archaeological or bioarchaeological theoretical take on social hierarchy probably has to grapple with the concept of power. This is often understood within a top-down framework. The concept of "power to" views all components of social interaction as embedded in systematic social practice (Miller and Tilley 1984). "Power to" and its companion, "powers over," (Spencer-Wood 2010) are associated with the dynamic in which one social entity coerces another into an action that they might not typically do or that might not be in their best interest (Miller and Tilley 1984). Foucault (1977, 1980, 1981) argued that power creates social reality itself through the relationships of the controllers over the controlled. A good deal of social tension may result, and the controllers may establish power through known, subtle, or unseen surveillance, especially in larger social systems.

Marx's (1978) top-down power concept may be particularly relevant to bioarchaeological thinking, or at least fairly easy to apply. This materialist framework identifies "exclusionary power," which is gained when one group possesses and transfers commodities or when one group consolidates resources in a way that excludes another group. Marx argued that the building blocks of social complexity were the dynamics among those who have versus those who have not (Feinman 2012; Marx 1978; Miller and Tilley 1984). In this vision, power is intrinsically linked to the ascribed value of objects, the labor time that is socially necessary to produce those objects, and who controls these products (Miller and Tiller 1984). A materialist vision of human biology based on political economy (Goodman and Leatherman 1998a, 1998b) may thus be a particularly useful way to understand many features of socially linked skeletal variation (and see below).

Often ruling parties demonstrate power through the use of ideology as articulated through ritual and the mystique of unshared and monopolized ritual knowledge (Foucault 1980). This manufactures the habitus of one group's right to control or rule. While not exclusively linked to a dichotomy between hierarchical elites and commoners, "power to" can also be corporate or shared between different groups or social segments, as is demonstrated among Australian Aboriginal moieties (Feinman 2012; Flannery and Marcus 2012). Though this type of power is shared within a group instead of individually based, it still creates social differentiation.

Sex and gender—two distinct concepts that cannot be conflated in bioarchaeology (Geller 2008)—are often liked to themes of hierarchy and in-

equality. Those who study ancient and modern human biological outcomes recognize that sex and gendered variations in skeletal biology, stress responses, and well-being go beyond X and Y chromosomes; in other words, sex and gender inequalities are powerful social constructs (Grauer and Stuart-Macadam 1998). Anthropologists have long observed that ideology and other features of social organization place many women of complex societies at a disadvantaged category compared to men, such that women's social existences may involve comparatively lower status or fewer advantages, especially in patriarchal cultures (Kellogg 2005; also, Conkey and Spector 1984; Williams and Bendremer 1997).

Yet archaeological and bioarchaeological studies of power, sex, and gender disparities must guard against simplistic and paternalistic tendencies in light of critical anthropological emic and etic definitions of gender (Miller 1993). It is factually inaccurate to envision women living their lives solely as defined by biology or lives in which "women's work" is defined by a naturally subordinate status to men (Conkey and Spector 1984; Kellogg 2005; Rosaldo 1980). Ultimately, the study of constructed gendered inequalities may help us understand a culture's expressions of itself. Gender is a complex formulation that is used in the social constructions of "the self" and personhood (Nelson 2004), allowing people to define themselves in relationship to other genders (Kellogg 2005). The multidimensional nuances of gendered lives can be exceedingly difficult to identify in archaeological or skeletal remains, given the many potential disjunctions between biological sex and gender. Gendered material culture can be ambiguous or difficult to recognize even in a thoroughly contextualized setting (Arden 2008). In some cases it may simply not be preserved. In addition, the conception and practice of gender and gender inequality in other cultures may not be as dichotomous as in our idealized Western sense (Joyce 2000; White 2005). There are great challenges in the archaeology and bioarchaeology of gender inequality, and the bioarchaeology of identity may be one way to productively explore these issues (Geller 2008).

Heterarchy

Horizontal differentiation in some form may occur across or within individual social strata (Crumley 1995). Hierarchy involves social differentiation in the vertical dimension; heterarchy represents the diversity within each level of that vertical scale. The bioarchaeological identification and study of heterarchy is both extremely challenging (again, necessitating intensely contextualized approaches) and vital to the study of social com-

plexity. Unfortunately, the bioarchaeology of heterarchy is comparatively underdeveloped.

Heterarchy helps account for the totality of diversity, complexity, and volatility of power between and among individuals and groups. "Powers with" and "powers under" differ from the singular, uniform notion of vertical power by reflecting simultaneously operating, multiple forms of agency that influence social complexity (Spencer-Wood 2010). These alternative expressions reflect different kinds of controls and negotiations in which power relations intersect with heterarchical complexities.

Heterarchical "powers with" are influences gained through group activities focused on cooperative and enabling activities. Actions such as inspiring, persuading, influencing, excluding, negotiating, cooperating, collaborating, forming alliances, and organizing group actions are good examples of these "bottom-up" forms of powers (Spencer-Wood 2010, 503). In this way, subordinate groups create a collective identity in which both the group and the individuals within it have agency and can question or change an existing social order. Behaviors such as persuading, influencing, or negotiating might seem ephemeral and empirically difficult to characterize in past societies, but thoroughly contextual archaeological and bioarchaeological studies may indeed be able to pick up some of their downstream effects if we are alert to their possible presence.

Subordinate groups have "powers under." The actions of such groups include resisting, bargaining, complying, adapting, accommodating, manipulating, and malingering. "Powers under" are associated with subaltern peoples' resistance to rulership and may run the gamut from symbolic resistance (Bawden 2005; Spencer-Wood 2010) and the act of setting oneself apart to nonviolent resistance to violent conflagration that can produce distinctive patterns of skeletal trauma or mortuary patterns (i.e., mass graves). Within human biology, some "powers under" and "powers with" may not be as apparent as hierarchical power expressions because they tend to produce more egalitarian outcomes. Alternative forms of power are especially important to an understanding of the potential consequences of social organization for skeletal remains.

Challenges and Prospects in the Archaeology of Social Complexity

Despite the advances in the study of social complexity, prospects for many additional developments exist. Multiple caveats, complexities, and challenges must be actively considered in any archaeological or bioarchaeological theorization of social organization. These encompass a spectrum

of linked conceptual considerations, theoretical issues, and new methodological opportunities.

Conceptual Reflections

As Trigger (1999, 380) observes, "simple correlations between archaeological interpretations and social conditions are encountered only rarely." There is always the concern that archaeological visions of social complexity may reflect the categories of the investigator rather than the "original" emic perspective that we should seek. It is important to guard against any tendencies to perceive ancient social hierarchies and heterarchies as static or concrete. Instead, we should probably anticipate degrees of fluidity or volatility between such categories by default. As noted earlier, social complexity on larger timescales does not necessarily involve perfectly linear trends. These processes can be flexible and reversible, at least in the short term (measured in spans of centuries). In many cases, it may be more accurate to approach the biocultural histories of societies or culture areas in terms of a cycling between greater and lesser degrees of social complexity amid the cyclic rise, collapse, and reorganization of complex societies (Schwartz and Nichols 2006; also Dillehay 2011). Such patterning could hold important implications for large-scale and diachronic bioarchaeological studies of health, such as that pursued by the Global History of Health Project and similar efforts.

An increase in the complexity of a social system may sometimes create more problems than it solves. The interactions of humans with their environment may lead to environmental degradation and the destabilization of complex cultures (Larsen 2006). For instance, in the Middle East, economic activities exhausted the soil. When irrigation ditches were filled with silt and salt, the result was soil that was too saline to grow crops (Redman 1992). On the ancient north coast of Peru, the peri-industrial scale of craft production was deleterious to the desert forest ecosystem and contributed to the political collapse of the Middle Sicán state (Goldstein and Shimada 2013). Climates may shift over millennia or El Niño Southern Oscillation (ENSO) events may play out over decades. One can begin to predict how ecological disruptions could result in declining health and surging violence as documented in the ancestral Pueblo southwest around AD 1100 (Harrod and Martin 2014). Yet even when contextual calamity surrounds the people of prehistory, they adjust, adapt, and find creative solutions to the challenges before them. For instance, complex polities may reconfigure

themselves into temporarily more decentralized entities (Pauketat 2004; Sandweiss and Quilter 2009) or they may develop more complex forms of culture, such as the creative but ephemeral experimentations in urbanism on the north coast of Peru that took place following the mega-ENSO of the sixth century AD (Shimada 1994; Bawden 1996).

Theoretical Challenges

Anthropological thinking about social organization has long been tied to levels of complexity, such as the typological categories of chiefdom and egalitarian, tribal, and state-level organizations—each of which has its own internally consistent and non-overlapping characteristics. While typological categories help us organize networks of information, they can be a double-edged sword. From Gnecco and Langebaek's (2014) perspective, those who construct typologies may be obsessed with classification for its own sake. Typologies tend to stifle new interpretive or analytical developments while essentializing ancient social forms of organization. Yoffee (2005) argues that typology is responsible for inventing a social-evolutionary mythology.

When typologies are used uncritically and applied automatically, researchers are only capable of seeing social variation in terms of dichotomies and tend to sideline alternative interpretations (Haber 2014). This is problematic when ancient realities do not align well despite our best etic ideas and frameworks. Perhaps the search for information that challenges typologies will be a productive contemporary use of such frameworks. As we note in the conclusion to this volume, it is hard to mask some of the more direct physical and biological effects of social inequality. The bioarchaeology of social complexity may serve as a powerful "typology buster" when we have misclassified ancient social organization. At the same time, skeletal data can just as well support the validity of a classification system if it is accurate. Well-contextualized skeletal data, especially when placed within multiple lines of independent archaeological data, has the potential to further evaluate the times and conditions under which the osteological paradox might manifest (DeWitte and Stojanowski 2015).

A definition of social inequality based solely on differential access to resources is a widespread practice and has a strong appeal for bioarchaeology, but it may contain certain limitations. According to Laguens (2014), this notion is perhaps too tightly associated with and limited by modern Western notions of economics. Fuller theoretical consideration may be needed

in order to incorporate consideration of broader material and nonmaterial resources in a society through the entire web of interactions between people, ecologies, ideologies, histories, and so forth.

Concepts of social class (and class-based resource distribution) underscore virtually all work on social complexity and inequality (including the chapters in this book), but Laguens (2014) recommends constructive introspection here as well. Classifications of social groups using previously defined diagnostic attributes, such as elite/non-elite dichotomies contingent on the quality and quantity of accessible resources, run the same risks as static typologies. Future work could explore Bourdieu's (1988) concept of resources (to include the wider range of material and immaterial categories of cultural, social, symbolic elements of power, prestige, and knowledge) using his (1990) concept of social space. The latter attempts to account for the ways that multidimensional people simultaneously act in different social and material realms, all tied together in a web of relative social relations. Together, these elements help us rethink "social class" as a "social field," which may be a more flexible, independent, and sophisticated way to conceptualize and interpret differences in resource allocation, power, and inequality between ancient social collectives (Laguens 2014). Bioarchaeological engagement with this wider vision will likely be quite interesting and novel.

Methodological Opportunities

A specific prospect in the study of social complexity involves greater alignment between mortuary analysis and bioarchaeology. For decades, mortuary practices were one of the most carefully examined elements of stratified societies (Saxe 1970; Binford 1971; Tainter 1975; Goldstein 1981; McHugh 1999). Burial in complex societies tends to be a "total social phenomenon" that integrates many aspects of social life (Beck 1995) with a variety of messages that the living encode in funerary rituals (Tarlow and Stutz 2013). Processual archaeology used funerary archaeology as a middle-range theory to support a neoevolutionary view of human cultural development. Adherents of this vision found that after some critique and introspection, greater contextualization helped demonstrate that this approach could uncover actual social realities (Brown 1995). Various postprocessual studies demonstrate that mortuary symbolisms may also be manipulated to intentionally obfuscate social heterogeneity or symbolically negate social inequality (Parker Pearson 2000; Shanks and Tilley 1982). In other settings,

burials may embody between-group competition and negotiation of heterarchical relationships (e.g., Parker Pearson 2000; Tarlow and Stutz 2013).

The study of mortuary contexts and the bones contained within them are still not well integrated into a unified approach (Knüsel 2010), despite the fact that they contain overlapping yet independent forms of information about social worlds. Goodman and Leatherman (1998a) would describe this as a symptom of the chasm between biological anthropology and cultural anthropology/archaeology, in which empirical objectivists are pitted against relativistic subjectivists. The result is a pernicious and unproductive divide between "science" and "theory."

On the one hand, many archaeologists have long considered the skeleton as a universal and fixed biological artifact that is incapable of imparting much socially relevant information (Gowland and Knüsel 2006, ix–x). When archaeologists invited physical anthropologists to examine human remains, it was most frequently in a lab setting, long after excavation had taken place, and the findings were often relegated to an appendix (Buikstra 1991). On the other hand, although physical anthropologists are steeped in evolutionary biology, they have not similarly engaged the relevant social theory and behavioral interpretations of their data. Gowland (2004, 136) noted that paleopathological data risks becoming objectified and irrelevant to historically determined conditions of human behavior and identity. Studies of social organization are perhaps a natural bridge between physical anthropology and archaeology that may help circumvent such an outcome. Indeed, many of the chapters in this volume independently brought together bioarchaeology and mortuary archaeology to illustrate some constructive synergisms across subfields.

The Bioarchaeology of Social Complexity

Social complexity and inequality are themes that have underscored many studies of human remains over the last forty years, either explicitly or implicitly. At this point, enough data has been gathered to allow for extrapolations of broad patterns on a global scale. In general, high-ranking or elite individuals often experienced better health than their subalterns. This outcome is especially common in what many refer to as ancient states, but it is not necessarily the case in forms of social organization that are traditionally labeled chiefdoms (Powell 1988). The evidence is represented in the patterns of diverse skeletal phenomenon, including enamel hypoplasias,

anemia and other metabolic disorders, traumatic injury, oral health, infectious diseases, degenerative joint disease, terminal adult stature, bone chemistry, and genetic variation (Ambrose et al. 2003; Cohen 1989; Cohen and Armelagos 1984; Cohen and Crane-Kramer 2007; Cucina and Tiesler 2006; Goodman 1998; Goodman and Leatherman 1998b; Larsen 2015; Martin et al. 2001; Powell 1988, 1992; Rathbun and Scurry 1991; Sakashita et al. 1997; Schepartz et al. 2009; Shimada et al. 2004; Steckel and Rose 2002; Swärdsted 1966; White et al. 1993; Wright 2006).

The most comprehensive treatise to date on the bioarchaeology of ancient social complexity was undertaken by Danforth (1999). Focused on the socioeconomic dimensions of skeletal indicators of nutritional status, she found that the economic mechanisms associated with prehistoric egalitarian societies ensured adequate nutrition for most members. Despite greater degrees of material culture differentiation and inequality, nutritional differences in transegalitarian and chiefdom-level societies were discernible only occasionally. To Danforth, this suggests that in order to remain in power, elites in chiefdoms did a relatively effective job of sharing resources with those they ruled. In state-level societies, different mechanisms were at play and great differences existed in nutrition and health between high- and low-status individuals.

The broader picture of biological variation in human remains is often, but not universally, concordant with the observations and expectations of modern health theory and contemporary health outcomes (e.g., Krieger 2008; Nguyen and Peschard 2003; Strickland and Shetty 1998; Victorino and Gautier 2009). Social complexity and the resulting biological inequalities are broad cross-cultural phenomena that are linked to a culture's ideology, power, and social identity and the high value it places on some people's lives (Goodman 1998). It is thus almost impossible not to consider an intensely materialist orientation in the bioarchaeology of social inequality (Klaus 2012), given the ways our biological interrelationships are so deeply intertwined with the quality of and access to resources. However, a broadened theoretical view of what items resources originally included or how people in ancient societies perceived them (sensu Laguens 2014) is likewise important.

The bioarchaeology of social complexity also has much to gain from the intersection of political economy and human biology. In our opinion, the directions, issues, and questions Goodman and Leatherman (1998a, 1998b) have suggested can be more thoroughly embraced in bioarchaeology. Their approach helps foster holistic, interdisciplinary, and contextual

understandings of the internal distribution of resources within a society. A political economy approach can be used in conjunction with the theory of embodiment. Skeletal phenotypes can be understood as entanglements with or "embodiments" of a socioeconomic reality and lived experiences (Farmer 2003; Gravlee 2009; Krieger 2001, 2004, 2005, 2008; Kuzawa 2008; and sensu Sofaer 2006). Evidence of biological stress, especially in the context of complex societies, is thus transformed from a static and simplistic "input-output" conception to a more nuanced and probably more realistic vision of a dialectical interplay among human biology and phenotypes and how society shapes them both.

Of course, it is naïve to argue that health equals wealth. Skeletal correlates of social status should never be seen in a one-to-one relationship with archaeologically defined social categories, just as such social categories may not always correspond well with skeletal variation (e.g., Robb et al. 2001; Saitta 1998). Using bioarchaeology to understand social complexity will never be a straightforward task. While contextualized osteobiographic or life history approaches may be one avenue (Becker, this volume), regional approaches are often necessary. While single archaeological sites are rich in data that includes information about architecture, technology, art styles, and settlement patterns, they often present mere snapshots of ongoing processes and rarely, if ever, reflect the whole of a past historical reality. Large and well-preserved skeletal samples tend to be even rarer and often present cross-sectional snapshots (Cohen and Armelagos 1984). We must also emphasize that the quality of a bioarchaeology of social inequality is dependent on ample contextual data and an in-depth understanding of the regional historical and social contexts. These can only be gained through the sustained and interdisciplinary investigation of multiple settlements of diverse size, nature, and periods. Finely contextualized bodies of archaeological data are fundamental if we are to truly draw out the multiple forms of meaning from skeletal data (e.g., Buikstra 1977; Buikstra and Beck 2006; Larsen 2015; Larsen and Walker 2009).

Overview of the Volume

The contributors to this book explore some of the possible complex interconnections between social organization and human biology in 15 chapters across three sections that span the Eastern and Western Hemispheres and present a wide spectrum of evidence and analytical techniques.

Analysis of differential human growth has been long associated with the

study of socioeconomic structure. Studies in Part I, Growth, Stature, and Social Organization, are our jumping-off point for the subject matter in this book. Carles Boix and Frances Rosenbluth (Chapter 2) use the frameworks of modern economics to demonstrate how stature and sexual dimorphism can be used to model inequality among human populations. They synthesize a wide range of data from archaeological and historic contexts to characterize stature variation during the Neolithic and the industrial revolution. First, they find that the shift from foraging to farming introduced inequalities significant enough to affect the distribution of health and stature and was fundamentally linked to the invention of coercive sociopolitical mechanisms. Second, the rise in sexual dimorphism that accompanies intensive agriculture may often reflect a society's more efficient allocation of nutrition and a drop in female bargaining power related to increased sexual division of labor and gendered inequalities. Third, political structures deeply shape nutritional outcomes. As economists, they draw upon a literature and upon measures of inequality that are foreign to most archaeologists. In addition to the substance of their findings, this chapter is a valuable cross-disciplinary contribution.

Lori E. Wright and Mario A. Vasquez (Chapter 3) reexamine stature variation at the Maya center of Tikal, Guatemala, from the Preclassic through the Terminal Classic periods (1 BC–AD 950). Using skeletal material Haviland (1967) first described, they include new samples and stable isotope data to develop an understanding of temporal and social variation in Maya growth processes. They find that archaeological distinctions between elites and commoners are associated with weak overall correlations between hierarchy and stature. Still, significantly shorter women are found in middle- and low-status domestic settings that correlate to isotopic indications of poorer nutrition and stunted growth. Their tentative finding is that the stature of middle- and lower-status males may have declined slightly over the span of Tikal's history, perhaps indicating a pattern of slowly declining nutrition as Classic Maya society peaked and faded.

While many of the chapters involve large samples and draw upon the perspective of comparative population biology, Marshall Joseph Becker (Chapter 4) uses a life history (or osteobiographic) approach in the analysis of the the remains of two individuals who have been identified as Prince Spytihněv, Duke of Bohemia, and his wife. Becker seeks to learn how the confluence of diet and royal social status in the ninth-century early Czech state affected growth and physical activity of these two elite people. Becker's

context-rich study tests the notion that terminal adult stature and skeletal robusticity may have embodied lives of privilege. The data reveal that while Spytihněv and his wife were notably more robust than people of the lower social rank, their stature falls within the range of all other males and females from this population. Becker makes the point that stature variation may not always have a one-to-one correlation with social rank, especially considering individual variation and the biocultural vagaries of the early Czech state. The bioarchaeology of such "emergent elites" helps propose key questions about biocultural relationships within early European states.

The way people assign meaning and value to sex and gender, as described earlier, is a key component of complex societies. Part II, Complexities of Sex and Gender, examines these issues in three Old World case studies. Sonia Zakrzewski (Chapter 5) focuses on the effects of emergent and entrenched differences in social differentiation and hierarchy in ancient Egypt between 5500 and 1785 BC. She examines diachronic patterns in terminal adult stature and limb proportions in Egyptian samples from the relatively egalitarian Badarian peoples through the highly complex and stratified Middle Kingdom. This diachronic approach suggests a number of outcomes, including the finding that mean adult stature increased from Badarian to Late Predynastic times but declined in the Middle Kingdom. Increasing degrees of sexual dimorphism and changing limb proportions also speak to the intertwined effects of social hierarchy, gendered social divisions, and the plasticity of human growth in ancient Egypt.

Lynne A. Schepartz, Sharon R. Stocker, Jack L. Davis, Anastasia Papathanasiou, Sari Miller-Antonio, Joanne M. A. Murphy, Michael Richards, and Evaggelia Malapani (Chapter 6) describe the archaeology, mortuary patterns, and dietary structures of people living in the Mycenaean (Aegean) culture of the Late Bronze Age (ca. 1675–1050 BC). Mycenaean society is well known as a hierarchical culture, and Mycenaean culture featured multiple social strata and complex heterarchies cross cutting class, sex, and gender. Skeletal remains from the major site of Pylos have begun to reveal some of the biocultural interplays within this society. This study illustrates the benefits of integrating written records with multiple lines of paleopathological and isotopic data. Schepartz and colleagues identify mortuary treatments that serve as indicators of social differentiation in terms of at least two clear-cut macro-strata within their sample. The analysis shows that the diet of the lower social strata was significantly poorer than that of the upper strata and that poor oral health was especially common among

women in general. Those of high status evidently had greater access to protein, and constructions of gender may have cross-cut vertical status differentiation.

In the archaeological record of China, Ekaterina Pechenkina, Ma Xiaolin, and Fan Wenquan (Chapter 7) quantify and compare mortuary pattern grammars and skeletal health markers between the sites of Xipo (Yangshao culture, a Middle Neolithic chiefdom, ca. 4000–3000 BC) and Xiyasi (a site that participated in the state-level, stratified Eastern Zhou dynasty, ca. 770–221 BC). At Xipo, Pechenkina and colleagues found no statistically significant differences in the health patterns of the three archaeologically defined social strata, even when taking into consideration sex-based variation in burial practices. In contrast, the Xiyasi sample from Bronze Age Zhou displays a mortuary program based on social status, age, and sex that divided the population into four ranked groups. Elite burials (mostly men) evidently had poor oral health that was likely attributable to differential consumption of status-linked foods. Pechenkina and colleagues found stronger associations between sex and specific funerary contexts, especially in the Eastern Zhou. Increasing social complexity appears to have been most directly associated with changes in social roles associated with sex (and by inference, gender).

Part III of this volume, Skeletons in Settings of Emergent Complexity and Stratified Social Systems, contains case studies that are, in many ways, problem-solving exercises; they either attempt to clarify the nature of social structure in a given cultural or temporal setting or seek to gauge the biological effects of emergent or entrenched ranked social systems. Sylvia Jiménez-Brobeil, A. Oumaoui, and M. G. Roca describe skeletal variation at Cerro de la Encina in Monachil, Grenada, Spain (Chapter 8). From ca. 2200–1430 BC, the people at Cerro de la Encina participated in the El Argar culture of Bronze Age Europe, an emergent state-level society defined by rather clear sociopolitical class divisions, settlement hierarchies, and gendered differentiation in mortuary treatments. The authors describe variations in health and social status in a small sample of 30 individuals and aim to overcome this issue using cross-contextual comparisons of multiple lines of evidence that includes funerary treatment. The authors find that nearly all signs of elevated morbidity correlate with individuals in lower-status funerary contexts. This chapter sheds new light on the potential biocultural consequences of emergent sociopolitical hierarchy in Spain and proposes new questions and research agendas for the bioarchaeology of Bronze Age Western Europe.

Paraskevi Tritsaroli (Chapter 9) investigates how social structure may have been reflected in funerary contexts at the Greek site of Pigi Athenas. The Middle to Late Bronze Age (1620–1500 BC) was a period of emerging and intensifying social complexity that involved small-scale settlement hierarchies, but the archaeological understanding of social organization for this period has remained limited. In a comparative case study of funerary treatment and skeletal biology, the authors consider the distribution of multiple skeletal pathological conditions in distinct tumuli-style burials at Pigi Athenas. Though social rank may have begun to displace the centrality of kinship, subtle variations in both funerary and bioarchaeological data indicate that the most important structuring factors were sex and age distinctions. Over time, the influence of differential diets, divisions of gender, and ritual feasting appeared as the people participated in a widespread Mycenaean system that shaped both gender and health in ancient Greece.

Gwen Robbins Schug (Chapter 10) offers bioarchaeological insight into the Indus (or Harappan) civilization in northwest India and Pakistan during the height of its urban phase, 2200–1900 BC. This culture was highly complex, as is shown through settlement hierarchies, bureaucracies, craft specialization, and communication and trade networks that spanned some 1 million square kilometers of territory. Despite more than a century of archaeological study, Indus social organization has remained difficult to define, especially with a lack of evidence of clear social differentiation. Robbins Schug examines osteological and funerary data to test the notion of a decentralized, heterarchical Harappa. Skeletal trauma and other forms of pathological data independently demonstrate that the people of Harappa experienced differential levels of vulnerability, violence, and exclusion of individuals in various spatially distinct mortuary settings. This pattern is most consistent with a system of vertical social stratification.

Similarly, Della Collins Cook, Ruth A. Brinker, Robin Moser Knabel, and Ellen Salter-Pedersen (Chapter 11) examine the skeletal evidence of hierarchy among the Hopewell peoples who lived in much of Eastern North America from 200 BC to AD 500. This work, which is part retrospection and part meta-analysis, takes a critical look at the archaeological work that considered Hopewell to be generally heterarchical and egalitarian. Cook's review of variations in funerary patterns and a host of biological data identifies patterns consistent with embodied social inequalities and draws upon evidence of better health and diet associated with those of inferred high status. While they acknowledge the substantial heterarchical dimensions of Hopewell social organization, Cook and colleagues argue that the pen-

dulum has swung too far from hierarchical models and that any archaeological conception of the Hopewell tradition must take into account the evidence of hierarchy that is visible in the remains of its people.

Tracy K. Betsinger (Chapter 12) investigates biological stress associated with an increasing emphasis on intensive maize agriculture, sedentism, population size, and differential access to protein-based dietary resources in two Mississippian palisaded sites in Eastern Tennessee during the local Dallas Phase, AD 1300–1500. Toqua was a multiple-mound center that was likely home to the main chief or chiefs of the region, while Citico was a smaller locale with a single mound. Betsinger found evidence of status-based funerary differentiation in these two locations; burials excavated from Toqua are considered to represent the "upper tier" of the polity and those from Citico are interpreted as its "lower tier." Statistically significant patterns demonstrate that non-elites from Toqua exhibited a higher prevalence of all stress markers. The mortuary programs of these two sites also exhibit sex-based divisions; males were typically interred in mounds and women in the village. Betsinger attributes this to simultaneous heterarchical expressions of different activity spheres. In addition, there are few biological disparities between elite and non-elite females, which Betsinger interprets to be the result of elite-sponsored, male centered feasting that drove expressions of inequality during the twilight of the Mississippian era.

Nancy A. Ross-Stallings (Chapter 13) assesses morbidity factors between two Mississippian populations from the Hollywood and Flowers #3 sites in the Mississippi River Delta that date to AD 1400–1600. The Delta is a resource-rich area with a large variety of domestic and wild resources that enabled these Mississippian people to be better nourished than many other affiliated populations. Ross-Stallings compares the health status of human remains from the Hollywood site (a high-status mound center) and the Flowers #3 site (a low-ranked satellite of the Hollywood center). She found a greater prevalence of biological stress and poorer diets among the people of the satellite settlement that indicates differential access to resources. This finding was further underscored by an extractive economic relationship; the Hollywood chiefs likely siphoned off various forms of tribute from their subaltern neighbors.

Ryan P. Harrod, Debra L. Martin, and Misty Fields (Chapter 14) examine skeletal stress markers, violence, and social inequality in two case studies drawn from hierarchically organized, ancestral Puebloan groups in the U.S. Southwest from the seventh to the thirteenth centuries AD (Late Pueblo I through the early Pueblo III periods). The first case study involves the

remains of two men from the Room 33 burial chamber at Pueblo Bonito. Using a contextualized life history approach, Harrod and colleagues first argue that the funerary setting and skeletal remains of these two men independently indicate they were highly ranked elites and ceremonial leaders. These men were not just at the social apex; they were probably the architects of hierarchy. The second case study involves the skeletons of women from the La Plata River Valley in the northern Colorado Plateau. These women were at the opposite end of the social spectrum, likely slaves captured through intergroup raiding. Their bodies revealed lives marred by abusive and socially sanctioned violence. In death, they were treated with a distinct lack of respect and reverence. The authors link such violence to ritualized activities that functioned as a kind of problem-solving strategy in times of environmental degradation in a marginal ecological setting.

Rebecca Storey, Lourdes Márquez Morfín, and Luis Fernando Núnez (Chapter 15) reconstruct biological stress patterns in pre-Hispanic urban settings at Teotihuacan in the Valley of Mexico (ca. 150 BC–650 AD) and at Monte Alban in the Valley of Oaxaca (ca. 100 BC–AD 500). Archaeologically identified rank (via burial location, mortuary elaboration, and settlement pattern data) was reduced to two broad categories—high and low social status. Odds ratio analyses revealed no difference in overall health patterns by status or sex. In other comparisons, higher-status individuals appear to have been buffered against various forms of stress. Overall, Storey and colleagues demonstrate potential expressions of osteological paradox outcomes. They find that social status and health in urban societies is a complex affair: intervening factors (population density, nutrition, and hygiene) structured by an urban setting can crosscut social strata and exert more influence on health than social organization alone.

Haagen Klaus, Izumi Shimada, Ken-ichi Shinoda, and Sarah Muno (Chapter 16) provide an examination of life and society in the heartland of the Middle Sicán culture (AD 900–1100) in Peru's northern Lambayeque Valley Complex. Here, various lines of archaeological data, (including carefully designed samples of skeletons from over thirty-five years of research) show strongly institutionalized expressions of social hierarchy between elite ethnic Sicán lords and the lower-status ethnic Muchik people living throughout the valley. Comparisons of skeletal stress markers between the two groups suggest that the lower-status Muchik endured measurably greater morbidity, more physically demanding lifestyles, and lower-quality diets. However, the remains of higher-status individuals revealed unique examples of interpersonal violence, perhaps related to risks associated with

their political station. Analysis of mtDNA and variations in tooth size indicates that social inequality also shaped their gene pool, such that elite Sicán and commoner Muchik groups did not widely intermarry. Klaus and colleagues propose that these biological differences can be explained by the theoretical construct of embodiment and that differences in access to resources was one of several factors that contributed to the collapse of the Middle Sicán political and religious system.

Haagen Klaus, Mark Cohen, Marie Danforth, and Amanda Harvey (Chapter 17) close the volume with commentary on and considerations of the bioarchaeology of social complexity. They identify several broad themes and issues running through the chapters and offer constructive critiques for future bioarchaeological studies of hierarchy, heterarchy, and other expressions of social organization in antiquity.

Conclusions

The work in this book is intended to present a starting point for new conversations and questions, as it connects to many persistent themes in archaeology and bioarchaeology. Hopefully, a focus on social complexity can help expand anthropological understandings of biological stress, evolution, and variation. The totality of the archaeological literature on social complexity is fundamentally stimulating and exciting, yet such literature may feel simultaneously less-than-humanized given the attention paid to large-scale, process-driven explanations of behavior, schematics of models describing culture change, and various theoretical abstractions. Bioarchaeological approaches can thus enrich the archaeology of social organization by bringing the lives of people themselves more into the spotlight.

Ultimately, the topic comes full circle. Social inequality is one of several contemporary global challenges. Our world today contains greater degrees of diversity and inequality than ever before in history. Bioarchaeology can be a voice that helps us better understand and navigate such contemporary issues in terms of the forces and factors that impact our biology and health. It is our hope that this work will contribute to a deeper perspective and a better understanding of how we have arrived at our current state of affairs—and perhaps provide some indication, at least in the short term, of where we as a species could be headed.

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I

Growth, Stature, and Social Organization

2

A Bone to Pick

Using Height Inequality to Test Competing Hypotheses about Political Power

CARLES BOIX AND FRANCES ROSENBLUTH

Human inequality between classes and between the sexes is of pressing intellectual and policy interest. Limited upward mobility and persistent gender wage gaps around the world preoccupy scholars who seek to understand their causes, while some politicians and policy makers aim to shrink the wealth divide. Mapping changes in inequality over the very long term and across many different kinds of societies would help adjudicate among various explanations that are offered. However, almost all of the data we have about inequality are from the post–World War II period. As a result, scholars mostly guess at the very long-term causes and consequences of inequality (Atkinson 1999; Esping-Andersen 1990, 1999; Kuznets 1955; Williamson and Lindert 1980).

This chapter pays tribute to Mark Cohen's pioneering work in biological anthropology by raising the possibility of using human osteological data to extend our knowledge of political systems and their economic effects back in time. Human height dispersion provides a rare, if still foggy and small, window into economic and political inequality from prehistoric times. In addition to using osteological data to track changes in living standards, which anthropologists and economists have already undertaken, we propose to study the distribution of heights *within* societies in order to understand their politics.

Human height data are potentially useful for this purpose because height varies systematically by levels of nutrition during childhood and adolescent growth spurts. If, as Eveleth and Tanner (1976, 222) suggest, two people who were genetically identical could be of different heights due to

nutrition alone, and if people had unequal access to food in these periods of development because of different political status, then their bones will offer a valuable new source of data.

In this chapter, we discuss only briefly the social scientific use of height data because it is well known to the readership of this book. We then propose some hypotheses about the distribution of political authority from prehistoric to early modern times that height measures may help test. These kinds of data, we suggest, can open up new areas for social science research and testing within bioarchaeology and beyond.

Height as a Source of Social Science Information

Human biologists generally agree that nutrition contributes to human height. For recent periods for which there are records, we have access to direct measurement of stature such as from census data and military, prison, and upper-school records.[1] For prehistoric periods, the only records that still potentially exist are skeletal remains derived from archaeological and anthropological research. The femur is the favored bone for gauging height from human remains because the correlation of these long bones with height in modern humans is statistically quite robust. The femur is also the densest bone in the body and is often better preserved than other long bones from which stature can also be estimated.

The use of these data is by no means problem free and poses significant challenges (see various chapters in this section). The ratios of femora length to height seem to vary somewhat across different human populations and ecogeographic space, requiring great care in drawing appropriate inferences. To the extent that invasions and migrations introduce novel genes, it is possible that we could misattribute differences in bone size to nutrition rather than to genetic endowment. Moreover, small sample sizes threaten the integrity of statistical inference. We hope that more exploration and collaborative scholarship will contribute to larger data sets and more precision.

From the scholarship of physical anthropologists, we know that both men and women were taller in pre-agrarian societies than in agrarian societies. Femora found in Paleolithic and Mesolithic sites seem to indicate an average height around 175 cm for men and of 165 cm for women; these are in the range of average stature today. People in pre-agrarian societies consumed abundant and diverse foods. This is explained by low population density; highly active lifestyles that limited female energy budgets, thus

lowering fertility rates; and the deliberate use of birth control strategies to prevent having more children than the habitat could support (Hrdy 1999). Compared to the scores of plant and animal species that foragers relied on, settled agriculturalists narrowed their diets to the few staples that they could more efficiently produce in smaller areas of land (Bogin 2001; Gould 1981; Hayden 1981; Hill and Hurtado 1989; Lee 1984). The narrower nutritional base of agrarian societies produced deficiencies that turn up in the form of bone lesions due to anemia (porotic hyperostosis), improper enamel formation in teeth (enamel hypoplasias), loss of bone mass, bone lesions from infections, and stunted growth (Cohen and Armelagos 1984; Goodman et al. 1988; Larsen 1995; Larsen 2015). For example, Bogin's (2001, 164) review considers that when compared to their foraging forbearers, the sedentary agriculturalists interred in the Dickson Mounds of the Illinois River Valley suffered from four times more iron deficiency and three times more infectious disease and deterioration of dental enamel over the 350-year period.

The industrial revolution further transformed human society in both the short and the long run. Very quickly, average heights declined as people crowded into unsanitary and land-poor urban centers. In the long run, however, the industrial revolution contributed to higher per capita incomes, some of which was used to improve public sanitation and nutrition. Eventually, these changes contributed to an increase in average heights. Improved health and nutrition from higher community-wide increases in income raises height closer to the genetic potential until increased income has no additional effect (Steckel 1995). Once societies are sufficiently wealthy to supply even the poorest in their midst with the minimal nutrition required to reach their height potential, height data lose their power to gauge intra-society inequality. But in human history, this is a recent event. For much of the last 10,000 years, many societies lived on the edge of nutritional sufficiency. This bare subsistence was sometimes driven by ecology and sometimes driven by internal social inequalities among a society's members.

Theoretical Framework

Human height provides an indirect measure of the economic and political structure of ancient societies by providing clues about the distribution of resources during a person's childhood and adolescence. Because childhood nutrition is vital for adult height and to the extent that powerful people

have greater access to nutrition for their children, patterns in the dispersion of human height should map on to political economic structures of various kinds in systematic ways. We take advantage of this fact to test hypotheses regarding inequality, both among men and between men and women and before and after major junctures of political economic change in human history. The most significant economic structural events were the Neolithic and industrial revolutions, but war and military technology are often hypothesized to have had significant effects as well. We can also begin to evaluate the importance of political institutional forms for inequality, measured both by size of the franchise and by the way checks and balances are distributed within a polity.

Pre-Agrarian Societies: Theoretical Expectations and Analysis

Inequality should have been low in hunter-gatherer or pre-agrarian societies because labor was the only factor in that economic world (land being abundant and capital being non-existent). In addition, a person's labor in those societies was relatively mobile: healthy people could theoretically leave a community and take up hunting and gathering elsewhere. Social groups were structured around extended families and complex political hierarchies were relatively unimportant (Boehm 1993; Cohen 1989; Lee and Daly 1999). As communities grew in size relative to the rate of productivity, violent competition could lead to warfare, although groups would split from existing bands to exploit new lands where possible (LeBlanc and Register 2003). Because access to resources was relatively open and equal, although close to subsistence levels, dispersion measures of height and health should be low for these societies.[2]

Boix and Rosenbluth (2014) used an extensive data set collected by Franz Boas and his research assistants on the age, height, and other anthropometric traits of about 16,000 Native Americans from some 290 tribes who lived across North America during the late nineteenth century to examine populations with relatively simple production technologies and limited warfare capabilities. The coefficient of variation (CV) of male and female height among Native Americans was low. About three-fourths of the tribes had a CV lower than 3.66 (and 90 percent had a CV below 4.0). Around half of all native groups had a CV of 3.3 or lower. The results for women are very similar. Notice that in the United States in 1977, the CV for 18-year-old boys was 3.66 and the value for 18-year-old girls was 3.57 (Steckel 1995).

A low measure of sexual dimorphism (measured by the difference in average male and female height divided by male height) might also be ex-

pected in hunter-gatherer societies on account of the economic viability of females who were independent of male patrons. Although previous researchers often note size differentials between males and females (Frayer and Wolpoff 1985; Friedl 1975; Low 2000; Rosaldo et al. 1974), there is little work that traces relative changes in size differentials over time within a given population. Sexual dimorphism, or morphological differences between males and females, including size, has a genetic component that is determined in each species by the size premium when competing for females. Monogamous species typically have the least sexual dimorphism. The human species is characterized by sexual dimorphism in the 10–15 percent range, which is consistent with the mild polygyny of human ancestry (Hrdy 1981, 1999). We are interested in the component of sexual dimorphism that is affected by nutrition in order to cast potential light on the relative valuation of males and females within a society.

The rationing of nutrition to children across the sexes should reflect both the different caloric needs of boys and girls given their work output and the longer-run "expected value" of a boy or girl. The longer-run "expected value" of the sexes is a complex concept because it includes both the efficient use of a community's human capital (male brawn might be seen as more valuable for cultivation when land is scarce) and the relative bargaining power of males and females given the sexual division of labor (male brawn is mobile while female association with child rearing tends to be a family group–specific investment). It is impossible to empirically disentangle these completely, but at least some component of the "expected value" is observable from height data because of the limited differences in the physical capabilities of children during the years of childhood when nutrition has its greatest impact on adult height. We also know from comparative evidence of femicide—the killing or fatal undernourishing of baby girls—that families make such decisions based on cost calculations that are either explicit or that become embedded in social norms (Hrdy 1999; Sen 1987). In hunter-gatherer societies, where males and females are both mobile in the sense that each is economically viable apart from the other, we expect this rationing across the sexes to be relatively low.

We conducted a preliminary test of this model of intra-male and intra-family equality on two hunter-gatherer groups: nineteenth-century Native Americans (Figure 2.1) and Jomon hunter-gatherers in the Japanese islands for whom we have data from the eighth-century BC (Table 2.1). While our results seem to confirm our expectations of relatively low societal inequality, we also recognize the need for more empirical work. It is puzzling, for

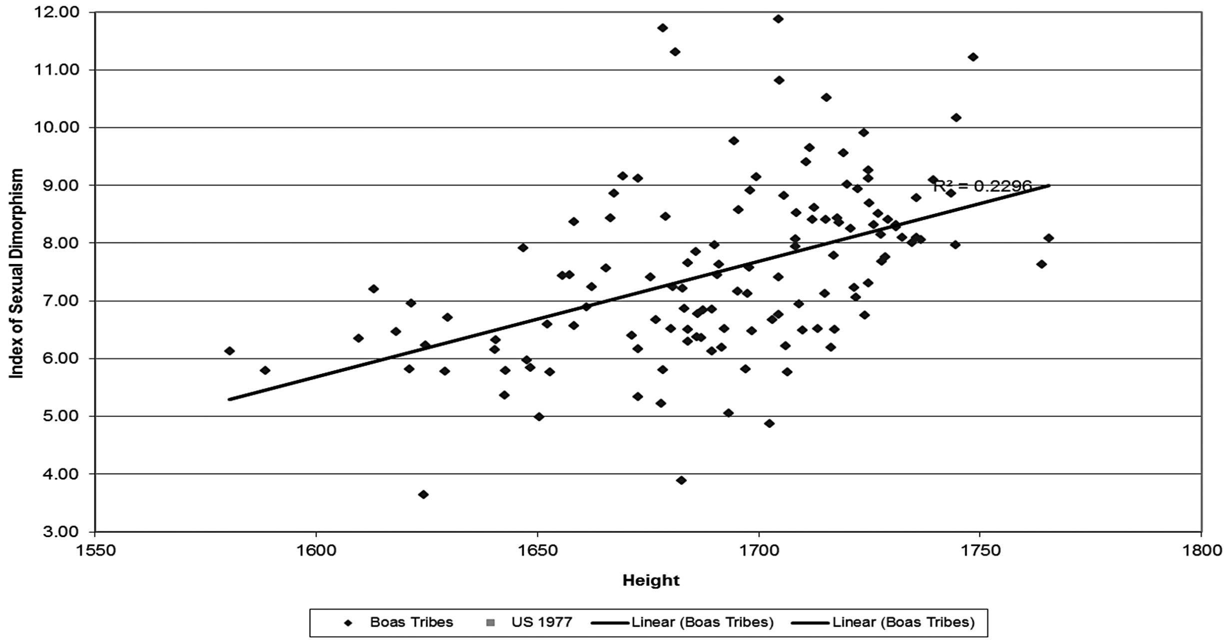

Figure 2.1. Male height and sexual dimorphism among Native Americans, based upon data collected by Franz Boaz (Jantz 1995).

Table 2.1. Height in Japan

	Men				Women				
Era	Observed	Mean	Std. Dev.	Coefficient of Variation	Observed	Mean	Std. Dev.	Coefficient of Variation	Sexual dimorphism[a]
Jomon	87	158.20	4.27	2.70	91	148.24	4.15	2.80	6.29
Yayoi	151	160.77	5.73	3.56	105	150.36	4.97	3.30	6.48
Medieval	20	158.05	5.49	3.47	29	146.05	4.01	2.74	7.59
Edo	36	157.19	4.90	3.12	31	146.17	4.07	2.78	7.01

Notes: The data for males used the Fujii method to estimate height. This method estimates height from femur length based on a particular femur-to-height ratio that is greater than the rates used for Caucasian populations (Nakanishi and Nethery 1999). Data for males is derived from Nakanishi and Netherly (1999); data for females is derived from Yamada (2002) and Tsuchiigahama Archeological Museum (1998).

[a]Sexual dimorphism is the gap between male and female height. The formula is 100 × (male height—female height) / male height.

example, that sexual dimorphism seems to be strongly and positively correlated with male height among the Native Americans but not for the Japanese hunter-gatherer population. Some anthropologists believe that sexual dimorphism typically increased with male height in premodern societies because male height is more sensitive than female height to nutritional deprivation. In other words, female height may be affected less by nutrition than male height; when resources are more widely available, both men and women grow but men grow more (Hamilton 1982). A second hypothesis concerns the extra value placed on males under conditions of greater intergroup competition or warfare (Divale and Harris 1976) or in conditions in which males, by virtue of contact with the Western world, have skills such as beaver trapping that give them a bargaining advantage over females. The Native American data showed that sexual dimorphism increased with the intensity of warfare (taken from Mishkin 1992) but was not correlated with amplification of agricultural practices. The collection of additional data may help sort between these alternative explanations, including consideration of other patterns of biological stress, ecology, and population history.

Agrarian Societies: Theoretical Expectations and Analysis

In an agrarian world, where both land and labor are the factors of production and there is some technological exploitation of land, the distribution of assets (and our dispersion measures) should vary as a function of at least three factors: population density, military technology, and political regime. Changes in the first two factors contributed to the emergence of states and therefore to the possibility that inequality may increase for reasons we will explain below. We expect the type of political regime to further define the extent of inequality.

Land Abundance and Military Technology

When the land/labor ratio is high and military technology is relatively unsophisticated, the distribution of assets is generally equal and state structures are weak (Rogowski and MacRae 2008). As in pre-agrarian communities, if land is abundant, it is less costly to move to new lands to avoid clashes with neighbors than to invest in political arrangements to solve those conflicts. Frontier societies therefore tend to be more equal and more prone to democratic governance. In addition, since military technology in pre-agrarian societies is simple—that is, the production of violence is labor intensive and does not rely on sophisticated weaponry such as chariots, horses, and heavy armor—self-defense is possible. Would-be predators at-

tempting to use violence to extract rents from others can subjugate very few peasants at a time.

The impact of land, labor, and military technology are probably related, in that population density leads to more investment in warfare. It is possible to check this logic by looking at cases where geography isolated a community for long periods of time—what Braudel (1979) the calls "mountain defense." Jared Diamond (1999) documents peaceable and less hierarchical communities that were wiped out suddenly once marauders developed technologies that enabled them to cross protective bodies of waters. William Divale and Marvin Harris (1976) find some evidence of an increase in femicide in more war-prone societies, where a greater value is placed on males. Boix (2015) exploits geographical discontinuities such as ruggedness of terrain and the presence of forests to show that political and economic inequality varied with war-fighting technologies: the use of horses and horse chariots (and the emergence of strong institutional hierarchies and a feudal class) was more extensive in flat areas than in mountainous terrains. The organizational needs of mobilization for war generate greater social stratification (Lynn 1991; Parker 1996; Parrott 1992; Roberts 1956), but whether this results in height dispersion depends on whether military technology is labor intensive, in which case we would expect military prowess to be fluid across generations without leaving a trace in relative height. If warfare or the operation of political systems is capital intensive, we would expect access to capital to be hereditarily protected.

Roving to Stationary Banditry

This egalitarian and "stateless" world collapses when land becomes scarce or weapons grow more sophisticated. Political conflict arises in regions where growing population density is coupled with a declining land/labor ratio. When less land is available, competition among farmers increases. In addition, the costs of invading and expropriating neighbors, who are now geographically closer than they were in a more sparsely populated world, diminishes dramatically. Similarly, once military technology becomes complex, previously independent farmers are faced with a stark security dilemma, since they may be robbed not just by other farmers but by professional bandits now endowed with the means to wreak havoc.[3]

As Olson pointed out (1993 2000), in the presence of 'roving bandits' that systematically raid farming communities and rob their crops, farmers eventually give those bandits local sway in exchange for protection against other external pressures. The price people will pay for protection or the

resources they will provide for a mobilizing army will be greater the more vulnerable the population is to external pressures such as possible invasion. In North and Thomas's framework (1974), feudal manors in medieval Europe can be seen as an exchange of peasant labor for knightly protection, where the degree of perceived vulnerability to predators and the competition for peasant labor jointly determine the nobility's premium. This characterization also applies to warring states in China in the third century BC or to civil war Japan in the fifteenth century. Inequality should increase as military technologies become more capital intensive. Even when warlords have an overwhelming military advantage, however, they will confiscate only to the point where they optimize rents.

The nobility's premium will be higher, we expect, in geographic locations without natural boundaries, in areas where labor is relatively abundant, or in areas where the nobility colludes to limit serf mobility (Ferejohn and Rosenbluth 2004). In regions that are protected by geographical barriers such as mountain chains or seas, the cost of invasions by external bandits is high and the security dilemma remains low. This may explain why areas such as the Swiss high valleys, Norway, and Iceland sustained rather egalitarian agrarian societies.

In addition, if farming involves a type of production strategy and a type of sociopolitical organization that requires cooperative practices that make farmers interdependent, the incentives to become a bandit are low. First, the existence of communal activities implies that collective action problems are sparse and that farmers can coordinate to defend the status quo against an internal enemy. Second, by negating or destroying many intercommunal ties, a strategy of expropriation may end up ruining the basis of production in the region. In other words, as Boix (2015, 63–73, 89–91) suggests, the solution to a prisoners' dilemma game may end up with an uncooperative cell characterized by an authoritarian (monarchical) regime or with a cooperative cell in which a self-governing community becomes viable.

Figures 2.2A and 2.2B summarize our discussion by comparing the kernel density distributions of male and female heights in what we classify as two simple-warfare societies (the Zunis and the Maya) and two complex-warfare cases (Egypt and Poland). Data for the former two come from the skeletal database from the Western Hemisphere compiled by Steckel and Rose (2002). The Egyptian data include direct measurements of mummies for two separate samples: thirty-one royal mummies (pharaohs and spouses) from the eighteenth, nineteenth, and twentieth dynasties of the New Kingdom (1550–1137 BC) that were radiographed in the early twenti-

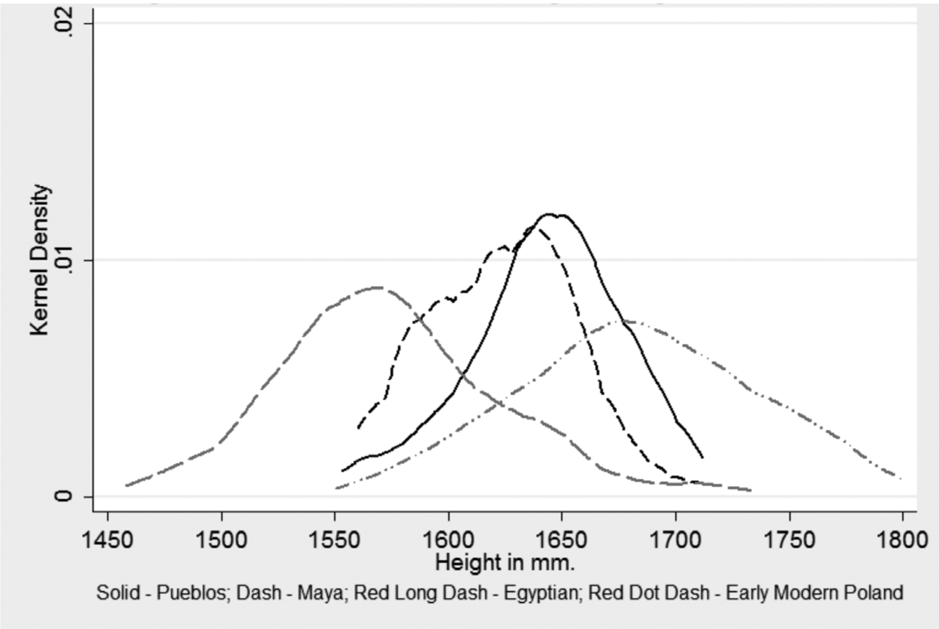

Figure 2.2A. Distribution of male heights in agrarian economies (Boix and Rosenbluth 2014).

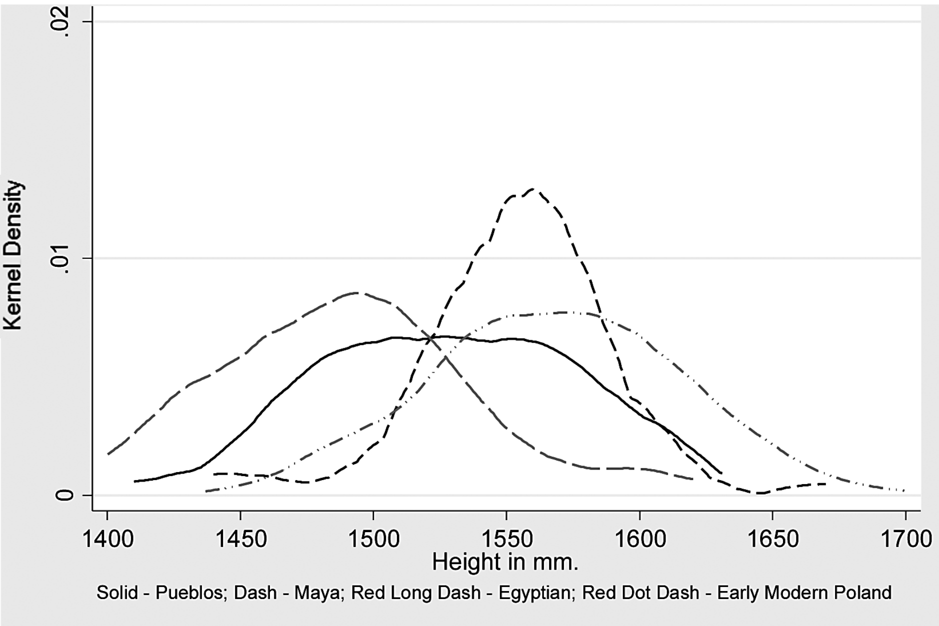

Figure 2.2B. Distribution of female heights in agrarian economies (Boix and Rosenbluth 2014).

eth century (Smith 1912) and 260 complete skeletons buried in the Upper Nile Valley (Asiut, Gebelen, and Aswan) for the Dynastic Period (Masali 1972).[4] The data from Poland draws upon 3,000 individuals from fifty-three cemeteries that date from the tenth to the nineteenth centuries (Kozak 1998).[5] Particularly for males, the variance in heights is much higher in Egyptian and Polish societies. This seems to be consistent with our hypothesis about the differential impact of politics and warfare.

Industrialization: Theoretical Expectations and Analysis

Since the eighteenth century, the process of industrialization and the introduction of new, more efficient production technologies has resulted in generally higher incomes and eventually a more relative equality in wealth distribution, at least in terms of the *longue durée* of the last 10,000 years. The process of investment that leads from invention to new commercial and industrial activities takes place, to start with, among entrepreneurs that postpone some consumption to invest in new assets. As those new assets generate higher returns than more traditional activities, there is a growing disparity of incomes between the new investors and the rest of society and thus more inequality. Yet at the same time, higher earnings in non-agrarian sectors gradually attract more individuals to these new activities. A growing proportion of the population decides to invest in the acquisition of those new types of assets, such as human capital, that generate higher salaries. In the case of the industrial revolution, the higher returns in manufacturing industries spread to larger segments of the population, and as the supply of educated workers increased, the wage gap between skilled and unskilled workers that widened at the beginning of the revolution narrowed again. This progression from agrarian to modernized economies tends to tread the path of Kuznets's inequality curve—inequality first grows with a shift in the structure of the economy and then declines progressively (Williamson 1991). In general, long bone size differentials should flatten with industrialization as incomes grow and are distributed more equally. Technological advancement should also reduce the gap between men and women if labor-intensive production is replaced by production using sophisticated tools and if capital-intensive warfare gains an increasing advantage over infantry-based conflicts.

Figures 2.3A and 2.3B explore the development of within-group height variance in contemporary societies from 1800 AD by plotting male and female CV and average height. Average height is taken as a proxy for development, in line with the existing literature. We draw our data from the

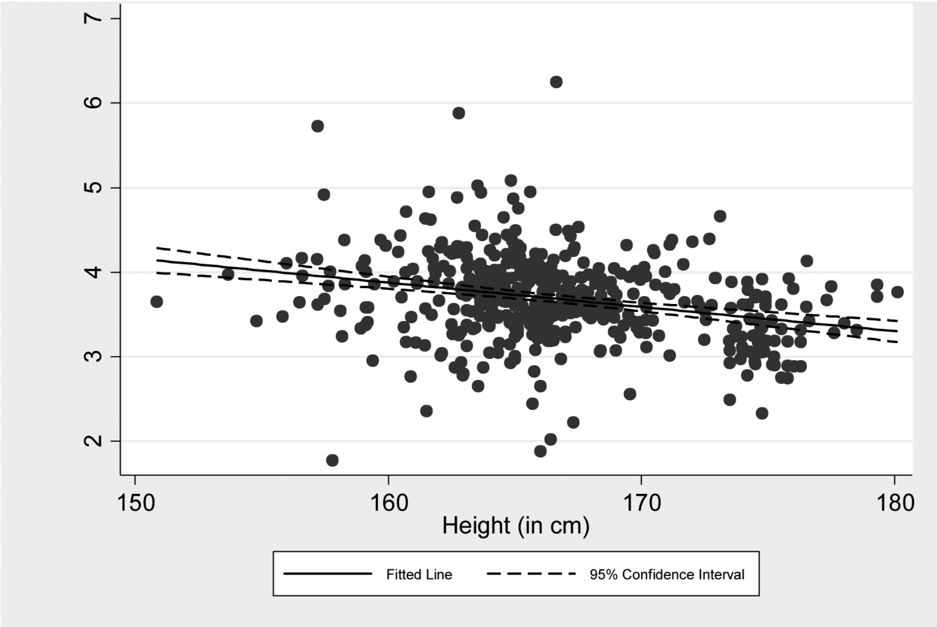

Figure 2.3A. Evolution of male heights and coefficient of variations since 1800 (Baten and Blum 2013).

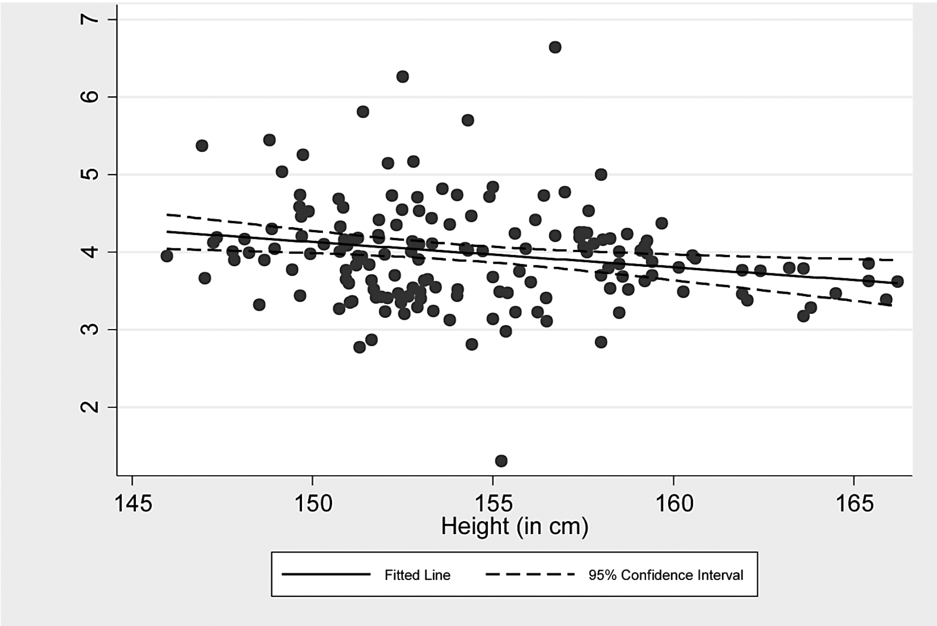

Figure 2.3B. Evolution of female height and coefficient of variations since 1800 (vanZanden et al. 2013).

several hundred articles listed in van Zanden et al. (2013) and include over 1,000 data points for male samples and close to 350 for female samples. Both figures display the individual observations, one for each population, and the fitted regression line with 95 percent confidence intervals. The CV declines by about 0.75 points for the full range of heights for both men and women. The variance in CV declines over time: shorter societies include very unequal and relatively equal distributions; taller societies are more homogeneous. These results are consistent with the proposition that economic development and modernization results in greater equality, although we acknowledge they could also reflect the declining measurability in the modern era of inequality through height data alone.

Discussion: Preliminary Findings and Open Questions

Human osteological data provide a potentially rich source of knowledge about times and places beyond the reach of more conventional tools of social science inquiry. Our preliminary investigation suggests several propositions and opens various additional lines of inquiry.

First, our data corroborate the general view that the shift of hunter-gatherer societies to sedentary agriculture often introduced structural inequalities both among men and between women and men and were severe and systematic enough to affect the distribution of the many of human biological factors that influence stature. Although better diachronic data are needed, comparisons between different types of agrarian societies seem to show that the level of intra-male inequality exceeds probable productivity differences among farmers and instead may reflect the development of coercive political machinery that builds up around the protection of storable assets.

Second, and more controversially, the rise in sexual dimorphism that accompanies labor-intensive agriculture may reflect both a society's efficient allocation of nutrition and the drop in female bargaining position that attends an increased sexual division of labor in which the female invests disproportionately in immobile assets such as children. These are distinct causal mechanisms, and examining the patterns of sexual dimorphism may help distinguish between them and in the process begin to unravel some of the enduring questions about patriarchy.

Third, we find that political institutions sometimes intervene decisively between economic structure and distributional outcomes. Sedentary agriculture, even of a labor-intensive sort, may be paired with a sharply hier-

archical political structure that unequally distributes resources or it may be tempered by a more democratic governance system. Skepticism about trying to endogenize the political apparatus entirely to economic structure seems in order, but there is much yet to learn about how economic systems, military technology, and governance structures are related.

Rulers and aristocrats in large centralized states have typically been able to command the resources that have made their offspring physically larger than commoners, even when they have been from the same genetic stock. Scholars have long suspected that this was true, but we are beginning to put some numbers on a fairly wide range of examples.

Broader Impact

In summary, human height provides a potential source of data with which to resuscitate debates about the political inequality that have foundered for lack of evidence. These include questions about the Kuznets curve, the nature of serfdom, effects of alternative institutional forms including absolutism, and the bargaining versus efficiency basis for variation in human sexual dimorphism. Social science indeed has much to gain from using new sources of information about the physical conditions under which previous human beings grew and lived.

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Notes

1. Data on military recruits are available starting in the late eighteenth century for Denmark, Norway and the United States; in the first half of the nineteenth century for Belgium, Britain, France and Sweden; and in the second half of the nineteenth century for Germany, Italy, Japan, Netherlands, Portugal, Spain and Switzerland. The anthropologist Franz Boas created an extraordinary data base in the late nineteenth century of hundreds of Native American Indians which we use in the pages below.

2. Comparing the Gini coefficients of three contemporary hunter-gatherer societies with that for classical Athens, Bollen and Paxton (1997) conclude that the former are all more egalitarian, particularly with respect to women.

3. On the other hand, Hirschman (1981, 250–51) indicated that if highly sophisticated weapons are available, a low land/labor ratio may in fact increase the incentives of those bandits to impose a slavery system precisely in order to curtail the exit options of the peasantry (Conning 2004; Domar 1970; Domar and Machina 1984; Dovring 1965). Scholarly debate regarding serfdom is ongoing, and height dispersion data can help us identify the conditions under which serfdom is both desirable from the standpoint of the powerful and is capable of extracting resources from unfree laborers.

4. We have no clear information about the social status of the Upper Nile Valley individuals. Note, however, that if they belonged to the nonroyal upper strata, this would strengthen our claims about inequality in Egypt even more because lower-status individuals were probably shorter.

5. Using Stata's kernel density procedure, we estimated kernel densities directly for Zunis and Maya since we have individual data. For Egypt, we have assigned the following percentage to each segment of the population: 5 percent to royal or aristocratic stock; 95 percent to commoners. For the commoners, we have randomly generated a distribution of individuals with a hypothetical standard deviation (Masali 1972 does not report the actual value) equal to a very low CV of 3 (to stack our deck against finding inequality). For Poland, we assigned values in line with the historical data available: 10 percent to nobility, 5 percent to cities, 10 percent to small towns, 10 percent to Jews, 65 to rural non-Jew. For each stratum, we randomly generated a distribution of individuals with a standard deviation corresponding to a CV of 3—again stacking the results toward height compression within each group.

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3

Stature at Tikal Revisited

LORI E. WRIGHT AND MARIO A. VÁSQUEZ

Ancient Maya civilization has been the focus of long-standing debate about the nature of social ranking in complex societies and archaeological definitions of urbanism (Chase and Chase 1992; Sanders and Webster 1988). The Classic period city of Tikal, located near the center of the Maya area, has featured prominently in these debates. Archaeological research has shown that Tikal was one of the largest of the lowland Maya sites; its estimated population was 62,000 inhabitants in its urban center by AD 700 (Culbert et al. 1990). Excavations of domestic architecture have documented a variety of residential forms, providing evidence of socioeconomic vertical differentiation. Similar patterns are seen in burial accompaniments.

William Haviland's (1967) influential study "Stature at Tikal" stimulated further research on ancient Maya social organization and contributed to the development of modern bioarchaeology by demonstrating the value of human remains for testing archaeological questions. After measuring skeletons from Tikal, Haviland described

- A decline in male stature beginning in the Early Classic period (AD 250–550)
- Taller stature of male individuals buried in tombs and shorter stature of those buried in simpler graves
- Shorter stature of females than males, which he interpreted as an effect of the lower relative social status of women.

From these observations, Haviland (1967) inferred that elites buried in tombs were afforded greater access to nutritional resources than commoners were and that health had declined during the Late Classic period (AD 550–700) due to increasing population density at Tikal. Haviland's landmark study is widely cited in both archaeological (Smith 1987; Marcus

2003; Chase, Chase et al. 2008) and bioarchaeological literature on hierarchy (Buikstra and Cook 1980; Danforth 1999; Robb et al. 2001; Wood et al. 1992; Zakrzewski 2003). Indeed, it could be argued that this work began the tradition of scholarship the led to the present volume.

Why Revisit Stature at Tikal?

Although Haviland's study is so widely cited, it has seen little scrutiny, and it is often presumed that the trends he described were strong and statistically supported. Although statistical testing was not included in Haviland's (1967) paper, the chronological patterning he describes is statistically significant. Late and Terminal Classic males were on average some 10 cm shorter than males from earlier occupations (ANOVA, $p = 0.02$, among Preclassic, Early Classic, and Late/Terminal Classic periods). However, Reed (1998, 65–66) found that a statistical difference between tomb and nontomb male stature was supported by two sample *t*-tests only when time periods are combined, not within the Early Classic or Late Classic samples alone. In a later study, Haviland and Moholy-Nagy (1992) described stature differences among burials in formal tombs, interments in intermediate-sized houses, and interments in small houses for both the Early and Late Classic periods but did not separate these data by sex or provide statistical analysis. Yet as Danforth (1994) has shown, Mayanists commonly extrapolate Haviland's inferences about health and status at Tikal to other Maya sites, even in the absence of supporting data. The results have also been extrapolated to represent prehistoric middle America at large (Bogin and Keep 1999).

To be sure, estimating stature for Maya skeletons is challenging at best due to the poor preservation of bone in the humid tropics. When Haviland's paper was published, the only available stature estimation formula for Mesoamerica was Trotter and Gleser's Mexican male equation (Krogman 1962; Trotter and Gleser 1958), so Haviland adjusted his stature estimates of Tikal females by the degree of sexual dimorphism American whites demonstrated in Trotter and Gleser's sample. The same year, Genovés (1967) published male and female stature equations that he derived from Mexican cadavers that are widely used in estimating the stature of Mayan remains. Although Haviland ultimately considered the Trotter and Gleser Mexican equations to be the best approach to estimating stature, he may also have included in situ measurements for an unspecified number of skeletons. He also compared the Trotter and Gleser estimates against in situ measurements for twelve skeletons, finding the Mexican equations a better match

to the in situ data than Trotter and Gleser's white male equations. Although the paper states that only extended skeletons were used for this comparison, its Figure 1 includes five flexed interments (PTP-049, 050, 059, 104, 160C). How does one measure the stature of a flexed skeleton in the grave? A comparison of his Figures 1 and 3 shows that he used the Trotter and Gleser–derived estimates preferentially over in situ estimates. It is not clear if he also included in situ data for other skeletons.

As with Maya remains elsewhere, long-bone metaphyses and foot bones were poorly preserved at Tikal, making in situ stature estimates quite problematic even for extended skeletons. To his credit, Haviland was breaking new ground: at the time, archaeologists rarely used statistical testing, measurement error was little studied, and osteologists were just beginning to understand the implications of biological variation in the body proportions of a population for stature estimation. Osteologists of the Maya will always be challenged by small sample sizes, poor preservation, and daunting constraints to the pursuit of statistical rigor. The work in this chapter faces the same challenges.

In addition to new methods for estimating stature, additional skeletal remains are available today that were not excavated when Haviland completed his study. Excavations by the Guatemalan Proyecto Nacional Tikal (PNT) have since recovered a large sample of skeletons that complements Haviland's original University of Pennsylvania Tikal Project collection (PTP). The PNT remains also suffer preservation challenges, and many of the PTP remains were reinterred at the site at the close of excavations. Thus, although the sample now available for stature estimation is not large, it differs considerably from Haviland's sample and offers an independent test of his observations. In this chapter, we revisit the evidence of social inequality as reflected in growth at Tikal using skeletal estimates of adult stature. In addition, we complement the stature evidence with stable isotopic measures of food consumption at Tikal. We take Haviland's conclusions as a point of departure, testing the following hypotheses:

- Stature declined over the span of occupation at Tikal.
- Stature was taller for individuals buried in elaborate mortuary facilities or in structures thought to be signs of high social status.
- Stature differences among social groups were a product of differential access to dietary resources.

The Ancient Maya Metropolis of Tikal

Excavations by the University of Pennsylvania's Tikal Project from 1958 to 1964 provided the first truly detailed understanding of the population history of a large Maya metropolis. It included both deep stratigraphic excavations in the monumental architecture of the city core and extensive survey and excavation of the surrounding settlement. Subsequent excavations in the Lost World sector of the city by the Guatemalan Proyecto Nacional Tikal in the 1980s further clarified the early history of the city.

Tikal was first occupied in Middle Preclassic times (800–350 BC) and monumental construction began soon thereafter. By the Late Preclassic period (350 BC–AD 250), the institution of divine kingship had emerged in the city, as it had elsewhere in the Maya area. Large funerary temples were constructed and periodically enlarged in the city's North Acropolis (Coe 1990) and an astronomical observatory temple complex was constructed in the Lost World complex (Laporte and Fialko 1993; Laporte and Fialko 1995). Study of royal tombs from the city center and the decipherment of hieroglyphic writing that appeared on Early Classic period monuments (AD 250–550) in the main plaza and elsewhere at the site revealed a history of dynastic rulership, the struggles of competing royal factions to gain and maintain control of the city, and Tikal's interaction with distant states (Coggins 1975; Coggins 1979; Jones and Satterthwaite 1982; Jones 1991; Martin 2003; Stuart 2000). Settlement surveys in peripheral Tikal demonstrated a near-continuous distribution of smaller domestic architecture that continued some 10 km from the city center (Puleston 1983) and suggested both a dramatic increase in population in Late Classic times (AD 550–850) and a precipitous decline during the Terminal Classic period (AD 850–950) (Culbert et al. 1990). As the dynasty had begun to falter several decades before this decline (Martin 2003), the last hieroglyphic monument ever erected at Tikal was placed in the main plaza in 869 AD. The city was essentially abandoned by AD 900. Explanations for the collapse of Tikal and other lowland Maya cities are varied and include climate change (Hodell et al. 1995), population pressure and agricultural overextension (Culbert 1988; Santley et al. 1986), and intercity warfare (Demarest 1996).

The ancient Maya diet and subsistence economy have been the subject of considerable study through paleobotany, zooarchaeology, and paleodiet (White 1999). Ancient Maya civilization was fueled by the cultivation of maize (*Zea mays*), beans, squash, a host of vegetables, fruits, greens, and other agricultural products (Lentz 1999). With the exception of domesti-

cated dogs and turkeys, animal protein was obtained from hunted fauna, such as deer, peccary, agouti, fish, and snails (Emery 2004). Stable isotope analyses of human bone collagen confirms a heavy reliance on maize consumption throughout Maya history but has also shown regional diversity in diets and some site-specific chronological dietary shifts (Gerry and Krueger 1997; Wright and White 1996). At Tikal, intensive agricultural production in nearby wetlands may have begun in Preclassic times and may have helped support the population of the city. Although the swamps were a source of protein such as *Pomacea* snails (Moholy-Nagy 1978), Tikal was not located on a major waterway and it is likely that freshwater fish did not contribute substantially to Tikal diets.

Identifying Social Hierarchy at Tikal

Just as stature estimation is problematic for the Maya, defining social groups is also challenging. Tikal has figured prominently in archaeological debates about the emergence and nature of hierarchy among the Maya (Arnold and Ford 1980; Chase and Chase 1992; Chase et al. 1990; Ford and Arnold 1982; Haviland 1981, 1982, 1992; Haviland and Moholy-Nagy 1992; Sanders and Webster 1988). Among the Maya, as for other groups, vertical status distinctions are often inferred from notional estimates of the energy expended to construct the architecture in which a burial was placed or to construct the grave facility itself (Arnold and Ford 1980; Tainter 1978) or from the abundance and diversity of grave goods accompanying a body in the grave (Rathje 1970; Welsh 1988).

Haviland used burial in "lavish tombs" as his criterion for identifying high social status skeletons but did not define this precisely. His terminology appears to refer both to grave construction and the contents of the grave. Recent studies of mortuary variability in the Maya area have typically followed Welsh's (1988) classification of grave form, which distinguishes simple graves, cists, simple crypts, elaborate crypts, and tombs and builds on earlier classifications (Smith 1972; Tourtellot 1990). A "tomb" then refers to a grave that is constructed of elaborate, often plastered, masonry; is typically corbel-vaulted; and is taller than 1.3 m. By this definition, there are several tombs at Tikal, but many of the abundant elaborate crypts are equally as opulent in material goods as the tombs.

Because of the large number of grave form types in Welsh's typology, we evaluate stature with reference to two condensed classifications. The first classifies graves as follows: 1) simple graves (no walls or delimiting features); 2) cists (with stones that either delimit or cap the grave) or simple

crypts (with capstones and low stone walls with a height of less than 50 cm); 3) elaborate crypts (with stone walls and capstones and an interior height of 50–130 cm) or tombs (with elaborate masonry, often vaulted, and an interior height of more than 130 cm); or 4) chultuns (underground chambers carved into the limestone bedrock that are normally used for storage). The second category collapses these categories to a comparison of skeletons in 1) tombs or elaborate crypts; and 2) all other grave forms.

Traditionally, archaeologists have inferred social status from grave accompaniments worldwide. This is especially true for the Maya, where a diversity of burial forms and accompaniments has long been interpreted in terms of social hierarchy (Coe 1956). Whether identified as symbols of social personae that made up "fossilized terminal statuses of individuals" (Peebles 1971, 69) in processual work (e.g., Gerry 1997) or as collective representations of "persons" manipulated by kin groups in work by agency theorists (Gillespie 2001), funerary diversity and complexity remain widely accepted as reflecting aspects of social and economic organization among the ancient Maya. The most elaborate of Tikal's burials contain polychrome pottery, jade and shell jewelry, stuccoed wooden sculptures, obsidian and chert tools, animal bones, and many other artifacts. In this chapter, we use a variety of individual artifact measures to compare status among burials, but we do not attempt an elaborate statistical analysis of grave goods.

While many of these artifacts are commonly considered to be good indicators of high status among the Maya, most are rare, a factor that hinders statistical comparison. Jade beads, pendants, earflares, and other jewelry are typically interpreted as signs of elevated status among the Maya. Because jade is more ubiquitous than other elite sumptuary goods, it makes a useful category in stature comparisons. Many graves contain one or more ceramic vessels. Since ceramic types changed through time, we used vessel form to classify mortuary ceramics (see Wright 2006). We compared stature among burials with ceramic plates, bowls, and vases and between those with a large assemblage of ceramics (more than five vessels) and those with more modest pottery.

Spatial analyses of social hierarchy at Tikal emphasize the energy expended in domestic architecture as evidence of status hierarchy. Because the Maya buried their dead beneath and surrounding their homes and in public and ritual structures, an individual's status can be inferred from the architectural context of a burial. Admittedly, burials in public contexts are more difficult to interpret and servants or slaves may have been interred in more elite contexts than their individual status might suggest. For Tikal,

Haviland later developed a typology of architectural forms that can be used to classify burials (see Moholy-Nagy 1994, 9–11). This classification distinguishes between 1) civic-ceremonial groups (special-purpose, nonresidential architecture, including temples); 2) range structure groups, composed of long corbelled-arch masonry rooms, which served as palaces occupied by the royal and most elite levels of society; 3) intermediate status groups, including one-room and range structures that may show some stone architecture and perishable superstructures; and 4) small structure groups without shrines that are built of perishable materials and housed the commoner population.

The diversity of burial and architectural forms at Tikal further contribute to an understanding of ancient Maya society at large and an understanding of the specific site as one that was socially diverse and in all likelihood economically ranked. Haviland's observation of stature differences among grave types and architectural groups provided some of the strongest evidence of economic inequality among the Maya. Subsequent studies of ancient Maya remains have struggled to document economic inequality (Wright 2004). Most such studies have used stable isotopic measures of carbon and nitrogen to look at differential access to maize and meat proteins in Maya diets. For instance, while isotopic patterns at Pacbitun and Caracol suggest that maize consumption may have been a prerogative of social status (Chase et al. 2001; White et al. 1993), other studies have found less clear evidence of dietary inequality (Reed 1998; Wright 2006). Two metastudies that have combined burials from different sites across the lowlands provide some support for systematic status differences in food intake (Gerry 1997; Somerville et al. 2013). Sommerville et al. report stability in diet among lower social strata that contrasts with considerable variability among sites and in various times at higher social strata. However, such studies rely on assumptions about uniformity in the social significance of mortuary symbols across the Maya area that may not be justified chronologically. Here, we use isotopic paleodietary measures to shed light on the stature patterning at Tikal.

Materials and Methods

Soon after Haviland's (1967) paper was published, Steele defined segments of long bones that were strongly correlated with bone length (Steele and McKern 1969; Steele 1970). Although his regression equations have been used with some success, subsequent studies have shown that the method

is complicated by variation in the proportion of the segments within a population, so population-specific regression equations (i.e., Brooks et al. 1990; Jacobs 1992; Steele 1970) are needed when the technique is used more widely. In the hope of facilitating stature estimates in fragmentary Maya remains, we developed regression equations to estimate maximum bone length of the humerus, femur, tibia, and fibula. The equations were developed from measurements of complete long bones from 100 modern adult Mayan skeletons (66 male, 32 female) exhumed by the Arzobispado de Guatemala (ODHAG) and the Fundación de Antropología Forense de Guatemala (FAFG) (Wright and Vásquez 2003). The skeletons are those of rural Maya civilians killed during Guatemala's civil war, which spanned from 1960 to 1996. Following Steele's original approach (Steele 1970), we defined bony landmarks on the tibia, fibula, femur, and humerus. The landmarks include several features Steele defined, such as the proximal margin of the intercondylar fossa and the midpoint of the lesser trochanter for the femur and additional points we defined; for example, the most proximal point on the greater trochanter. Landmarks are defined in Wright and Vásquez (2003). By regressing segment length on bone length (Classical Calibration), we generated 75 equations with $r^2 > 0.85$ (25 for males, 25 for females, 25 for the combined sexes). Standard errors are less than 2 cm for sex-specific formulae and less than 1.2 cm for combined sex formulae (Wright and Vásquez 2003).

As Haviland found, an eclectic approach is necessary for estimating stature at Tikal. In addition to measuring the length of all measurable complete long bones, we use the regression equations described above to estimate the complete length of fragmentary Tikal femora, tibiae, fibulae, and humeri. We considered only the bones that showed complete fusion of the epiphyses and/or where other measures of skeletal age suggest that the remains are those of adults. Mario Vásquez measured all the long bones from the PNT excavated skeletons and the PTP bones that are curated at Tikal National Park. Wright also measured several PTP remains in Philadelphia.

In all research on ancient Maya skeletons, sex determination is hampered by poor preservation of pelvic remains, and by necessity one must use sexual dimorphism in skeletal robusticity to estimate sex for many skeletons. Fortunately, skeletons with adequately preserved long bones for stature analysis also have better-preserved morphological sex indicators. However, there is no easy solution to the circular problem that body size contributes to sex estimation (Danforth 1994). In order to estimate the sex of more poorly preserved remains, we generated discriminant functions

using individual postcranial measurements for Tikal skeletons with secure pelvic sex identifications and weighted the posterior probabilities of the classification outcomes against cranial and pelvic sex criteria to identify sex for more fragmentary remains.

We applied the Genovés (1967) regression equations to estimate stature from long-bone length. We ranked stature estimates for each individual by bone (femur >tibia >fibula >humerus) and by the r^2 for each forensic equation to arrive at a best long-bone estimate for each skeleton. In an earlier analysis (Vásquez Gómez 2004), the combined sex equations from Wright and Vásquez (2003) were used to estimate bone length since we had not yet finalized sex assessment for all skeletons. However, we recalculated bone lengths for this chapter using sex-specific equations. For a small number of skeletons, only a radius or ulna was available for stature estimation. As Tikal radii and ulnae are proportionately longer than those in Genovés's series, we generated stature equations for these bones for Tikal skeletons with stature estimates based on the femur, tibia, fibula, or humerus. We used estimates from the radius for four skeletons and estimates from the ulna for three skeletons. Most of the forearm estimates are for PTP skeletons, from which many bones were discarded at the close of the Pennsylvania fieldwork.

We compared stature estimates across time and status both with and without the less reliable forearm estimates. We included a slightly larger sample in this chapter than was the case in Vásquez Gómez's earlier work (Vásquez Gómez 2004). Using only major long bones, we estimated the stature for 37 skeletons (19 male, 18 female). When stature estimates derived from radius and ulna measurements could be included, stature could be estimated for 44 skeletons (21 male, 23 female), a smaller quantity than Haviland's 55 individuals. Although our sample contains fewer male skeletons, it has slightly more female skeletons than Haviland's sample did. Our sample contains fewer individuals from structures near the main plaza and a larger proportion from residential excavations to the south of the Lost World pyramid than Haviland's sample did. Late Classic period remains dominate both samples, as Late Classic architecture is ubiquitous on the surface and population density peaked at this time.

Results: Stature Revisited

In our sample of skeletons from Tikal as a whole, male stature averages 159.6 ± 4.6 cm, while female stature averages 146.9 ± 8.3 cm, a highly sig-

nificant difference (Student's *t*-test, $p < .0001$), as expected. These values differ little from the means by sex in Haviland's sample (male 160.4 ± 10.0 cm; female 147.6 ± 4.9 cm). Only seven females and two males are included in both our sample and Haviland's sample. Our stature estimates (based on tibia and radius) for both males are 6 cm shorter than Haviland's estimates. For females, three estimates are within a centimeter (based on a femur, a tibia, and a radius), while four estimates are 7–10 cm shorter (based on a tibia, a radius, and two ulnae). For females, our estimates using Genovés's (1967) female stature equations are about 2 cm shorter than calculations using Haviland's modified Trotter and Gleser method; this accounts for some of the discrepancy. We hesitate to combine our data with Haviland's due to these methodological differences.

The sample contains a small number of individuals recovered from problematic deposits (PDs) or from similar deposits that were enumerated as "burials." These are generally non-articulated remains and may represent primary burials, secondary burials, or a combination of the two modes. Such PDs occur in both public and domestic contexts. As the social identity of the remains in these deposits is unclear, we made some comparisons both including and excluding these few remains. However, it is probable that many PDs are secondary deposits of revered ancestors (McAnany 1995). Most in the sample are from domestic contexts, so we retained them for most analyses. In the sample as a whole, Student's *t*-tests showed no difference in the stature of articulated and non-articulated remains for either males ($p = 0.53$) or females ($p = 0.12$). Hence, we included stature data from these contexts for most of our analyses. Haviland's sample also included a few such contexts.

Table 3.1 contains average statures by sex for each time period, calculated both with and without the less reliable radius and ulna estimates. Statistics for chronological patterning in stature and archaeological measures of social status are in Table 3.2. Calculating for each sex separately, we used an analysis of variance (ANOVA) test to evaluate comparisons among three or more categories and a Student's *t*-test for comparisons for which there are only two categories. We combined Terminal Classic burials with the Late Classic period because of the small number of skeletons from this time period and its short duration. We kept the few Postclassic remains separate for most comparisons because of the decidedly sparse post-collapse occupation. Analyses of variance comparing Preclassic, Early Classic, Late/Terminal Classic, and Postclassic period remains do not show significant differences between time periods for either sex or using either set of es-

Table 3.1. Descriptive statistics for stature, chronology, and architectural patterns in stature at Tikal

Chronology	Architectural form	Stature measure	Males Mean	Males S.D.	Males N	Females Mean	Females S.D.	Females N
Preclassic	All combined	Including radius & ulna	162.7	4.8	2	140.5	0.3	3
Early Classic			161.2	2.6	7	146.7	10.5	4
Late & Terminal Classic			158.0	5.3	11	147.3	8.4	15
Postclassic			158.4	—	1	149.5	—	1
Preclassic	All combined	Best preserved long bones	166.1	—	1	140.5	0.4	2
Early Classic			161.7	2.6	6	146.7	10.5	4
Late & Terminal Classic			158.0	5.3	11	148.1	9.4	12
Postclassic			158.4	—	1			0
All periods pooled	Small	Including radius & ulna	158.1	1.4	4	140.0	8.9	6
	Intermediate		160.4	3.6	7	149.0	5.4	11
	Range		159.1	6.1	3	160.9		1
	Civic-ceremonial		158.4	6.9	5	145.7	7.6	5
Late & Terminal	Small	Including radius & ulna	158.1	1.4	4	141.6	8.9	5
	Intermediate		158.6	5.4	2	148.0	5.7	8
	Range		157.8	7.9	2	160.9		1
	Civic-ceremonial		154.0	9.6	2	157.4		1
Preclassic & Early Classic	Small	Including radius & ulna			0	131.9		1
	Intermediate		161.1	3.1	5	151.6	4.7	3
	Range		161.8		1			0
	Civic-ceremonial		162.7	4.8	2	140.5	0.3	3
All periods pooled	Small	Best preserved long bones	158.1	1.4	4	140.0	8.9	6
	Intermediate		160.7	3.9	6	150.7	5.4	8
	Range		159.1	6.1	3	160.9		1
	Civic-ceremonial		158.1	8.0	4	146.1	9.8	3

Late & Terminal	Small	Best preserved long bones	158.1	1.4	4	141.6	8.9	5
	Intermediate		158.6	5.4	2	150.2	6.3	5
	Range		157.8	7.9	2	160.9		1
	Civic-ceremonial		154.0	9.6	2	157.4		1
Preclassic & Early Classic	Small	Best preserved long bones			0	131.9		1
	Intermediate		161.7	3.3	4	151.6	4.7	3
	Range		161.8		1			0
	Civic-ceremonial		166.1		1	140.5	0.4	2

timates. Pairwise comparisons between periods are also nonsignificant. However, if we collapse time periods to Preclassic/Early Classic and Late Classic through Postclassic periods, the difference is nearly significant for male stature. For the earlier era, the average male was only 4.2 cm taller than the average male during the later era, considerably less than the 10 cm decline change shown in Haviland's data. Female stature is not statistically different among periods individually or when combined to compare Preclassic/Early Classic and Late through Postclassic periods.

Turning to archaeological indicators of social hierarchy, although Haviland found tomb males to be taller than nontomb males in a combined Early and Late Classic sample, there are no notable stature differences in our sample by grave form. This is true for each sex, using both the better long-bone estimates alone and then including radius and ulna estimates. Moreover, stature differences among grave types are unsupported when all time periods are combined, when Early and Late Classic graves are pooled, or when only Late Classic graves are included in calculations (Table 3.2). In total, the sample contains only four females and three males buried in elaborate crypts or tombs, so small sample size of the highest social level may well play a role in this pattern. Haviland's sample contained many more burials from the ritual core of the city, including burials of known rulers, but long bones are no longer available for study for most of these. Artifactual correlates of social status also showed no stature patterning in our sample. We found no statistical differences in stature between burials

Table 3.2. Statistical results of stature analysis

Comparison	Categorical variable	Subsample	Data included	Test	Males			Females		
					F or *t*	*p*	*df*	*F* or *t*	*p*	*df*
Chronology	Preclassic, Early, Late/Terminal, Postclassic	Including problematic deposits	Best preserved long bones	ANOVA	1.546	0.571	3, 15	0.581	0.571	2, 15
		Including problematic deposits	Including radius ulna	ANOVA	1.107	0.373	3, 17	0.599	0.623	3, 19
	Preclassic, Early, Late/Terminal, Postclassic	Excluding problematic deposits	Best preserved long bones	ANOVA	1.535	0.254	2, 12	0.711	0.508	2, 14
		Excluding problematic deposits	Including radius ulna	ANOVA	1.038	0.379	2, 14	0.678	0.576	3, 18
Chronology	Pre/Early vs. Late-Post	Including problematic deposits	Best preserved long bones	*t*-test	2.023	**0.059**	17	-0.764	0.456	16
		Including problematic deposits	Including radius ulna	*t*-test	1.867	**0.077**	19	-0.929	0.363	21
Grave type	Simple, cist/crypt, elaborate/tomb, *chultun*	All periods combined	Best preserved long bones	ANOVA	0.350	0.789	3, 11	0.369	0.776	3, 12
		All periods combined	Including radius ulna	ANOVA	0.409	0.749	3, 13	0.771	0.525	3, 17

		Late & Terminal	Best preserved long bones	ANOVA	0.169	0.850	2, 4	0.394	0.688	2, 7
		Late & Terminal	Including radius ulna	ANOVA	0.169	0.850	2, 4	0.395	0.683	2, 10
Grave type	elaborate/tomb vs. all other	All periods combined	Best preserved long bones	*t*-test	0.619	0.546	13	0.860	0.404	14
		All periods combined	Including radius ulna	*t*-test	0.658	0.520	15	1.464	0.159	19
		Early & Late/ Terminal	Best preserved long bones	*t*-test	0.501	0.626	11	—		12
		Early & Late/ Terminal	Including radius ulna	*t*-test	0.509	0.620	12	0.679	0.507	15
		Late & Terminal	Best preserved long bones	ANOVA	0.007	0.934	1, 5	0.228	0.645	1, 8
		Late & Terminal	Including radius ulna	ANOVA	0.007	0.934	1, 5	0.841	0.378	1, 11
Jade artifacts	jade vs. no jade	All periods combined	Best preserved long bones	*t*-test	-0.654	0.523	14	0.006	0.994	14
		All periods combined	Including radius ulna	*t*-test	-0.311	0.759	16	0.235	0.816	19
Ceramic plate	plate vs. no plate	All periods combined	Best preserved long bones	*t*-test	0.245	0.809	14	-1.055	0.309	14
		All periods combined	Including radius ulna	t test	0.308	0.762	16	-0.936	0.360	19
Ceramic vase	vase vs. no vase	All periods combined	Best preserved long bones	*t*-test	0.245	0.809	14	-0.100	0.921	14

(*continued*)

Table 3.2—*Continued*

Comparison	Categorical variable	Subsample	Data included	Test	Males			Females		
					F or *t*	*p*	*df*	*F* or *t*	*p*	*df*
		All periods combined	Including radius ulna	*t*-test	0.308	0.761	16	-0.292	0.773	19
Ceramic bowl	bowl vs. no bowl	All periods combined	Best preserved long bones	*t*-test	0.147	0.885	14	-1.207	0.243	14
		All periods combined	Including radius ulna	*t*-test	0.211	0.835	16	-0.270	0.789	18
>5 vessels	>5 vessels vs. 0–5 vessels	All periods combined	Best preserved long bones	*t*-test	-0.763	0.457	15	—		14
		All periods combined	Including radius ulna	*t*-test	-0.585	0.566	17	1.046	0.308	19
Architecture	small, intermediate, range, civic-ceremonial	All periods combined	Best preserved long bones	ANOVA	0.290	0.830	3, 13	3.550	**0.040**	3, 14
		All periods combined	Including radius ulna	ANOVA	0.270	0.840	3, 15	3.660	**0.030**	3, 19
		Late & Terminal	Best preserved long bones	ANOVA	0.290	0.830	3, 6	2.720	0.110	3, 8
		Late & Terminal	Including radius ulna	ANOVA	0.290	0.830	3, 6	3.070	0.073	3, 11
Architecture	small vs. intermediate	All periods combined, including pds	Best preserved long bones	*t*-test	1.605	0.143	9	3.465	**0.004**	14

		All periods combined, including pds	Including radius ulna	*t*-test	1.237	0.247	9	2.613	**0.019**	15
Architecture	small vs. intermediate	All periods combined, excluding pds	Best preserved long bones	*t*-test	1.323	0.227	7	3.237	**0.007**	13
		All periods combined, excluding pds	Including radius ulna	*t*-test	0.810	0.444	7	2.386	**0.032**	14
Architecture	small vs. intermediate	Early & Late/ Terminal, including pds	Best preserved long bones	*t*-test	-1.286	0.234	8	-2.817	**0.016**	12
		Early & Late/ Terminal, including pds	Including radius ulna	*t*-test	-1.238	0.247	9	-2.613	**0.019**	15
Architecture	small vs. intermediate	Late & Terminal, including pds	Best preserved long bones	*t*-test	-0.232	0.828	4	-1.770	0.114	8
		Late & Terminal, including pds	Including radius ulna	*t*-test	-0.232	0.828	4	-1.603	0.137	11

Note: Statistically significant results in boldface.

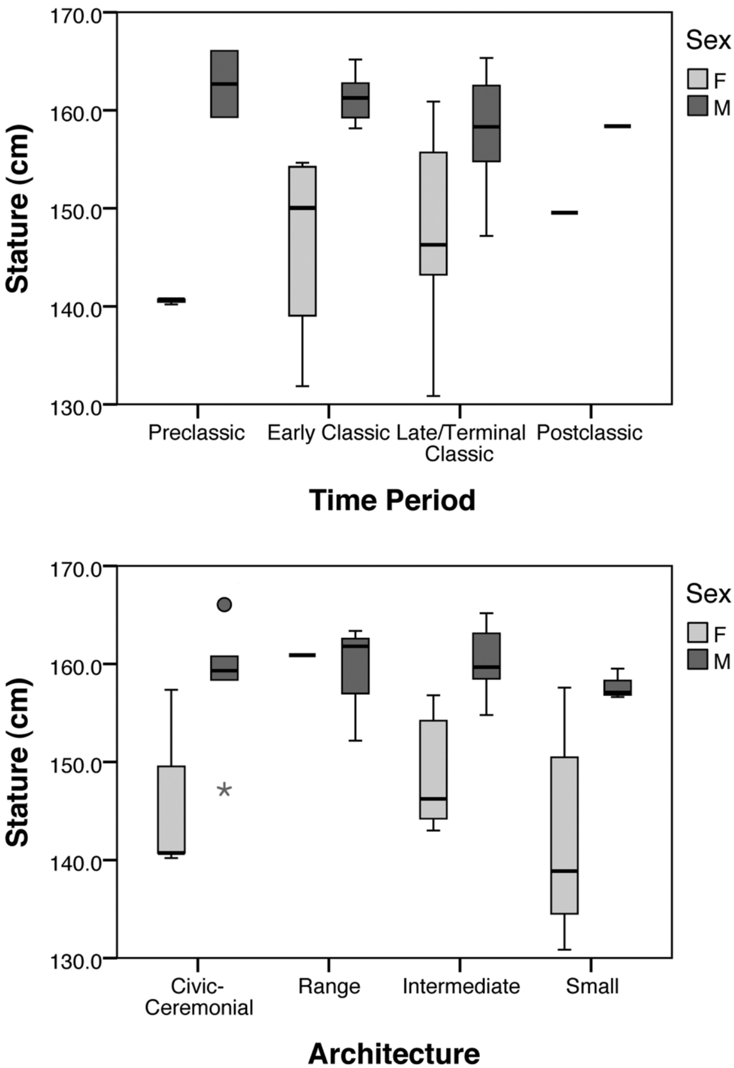

Figure 3.1. Stature estimates (including radius and ulna) for Tikal by time period and by architectural context.

with and without jade beads, ceramic plates, vases, or bowls or those buried with more than five vessels and those buried with fewer than five vessels.

The only measure of hierarchy that shows statistically significant stature patterning is the architectural context of the burial (see Fig. 3.1, Tables 3.1 and 3.2). When all chronological periods are combined, females show statistically significant stature differences among architectural forms. Con-

versely, males demonstrate stature homogeneity among these group types. Females interred in civic-ceremonial contexts averaged 145.7 ± 7.6 cm, one range-structure female was 160.9 cm (PNT-036, Late Classic, which has ambiguous sex indicators), intermediate-group females averaged 149.0 ± 5.4 cm, and small-domestic-group females averaged 140.0 ± 8.9 cm. The ANOVA for the female sample of the Late and Terminal Classic burials is nearly significant among these architectural groups when radius and ulna estimates are included but is not significant in the smaller sample of more secure long-bone estimates. Most of this status discrepancy appears to be between burials in small and intermediate domestic groups, between which females differ by 9.0 cm using radius and ulna estimates or 10.7 cm using the larger and more reliable long bones alone. For all periods combined, females in intermediate domestic groups are taller than those in small domestic groups whether non-articulated burials are considered or not. The female status difference remains when only Early, Late, and Terminal Classic burials are considered together. Although the mean difference in female stature between the two house types is 8.6 cm for Late and Terminal Classic burials alone, the difference is not statistically significant ($p = 0.114$); this is presumably attributable to the considerably smaller subsample size.

Discussion

Overall, our analysis found weak support for our first hypothesis involving the decline in male stature as identified by Haviland (1967). We found that males from Late through Postclassic periods perhaps had slightly shorter stature than the males from earlier times. This decline is not paralleled among female skeletons, for which Haviland also did not report any change. We found minimal support for our second and third hypotheses in our sample regarding the social differences Haviland reported among burials based on grave form and accompaniments, whether it be for males or females. In part, this may be due to sampling error, since our sample contains relatively fewer of the sumptuous royal tombs Haviland studied and the diversity of burial goods is low in our sample. The scarcity of highest elites in our sample may also explain the lack of evidence of male stature decline if we are indeed missing the tallest elite males from the city.

Instead, the strongest evidence that can be discerned for effects of hierarchy on stature were among females alone and among the contexts in which they were buried. Females in smaller domestic groups were substantially shorter than females in more elaborate architecture. However, because of

the small sample sizes, especially during the Early Classic, it is not possible to statistically test changes in this pattern between earlier and later Tikal occupations. Haviland and Moholy-Nagy (1992) also described a stature difference between these architectural forms but did not report the sex of skeletons used in their comparison. We presume that they compared only male skeletons, given the mean statures they illustrated. Indeed, Haviland (1967, 323) suggested that only male stature was affected by nutritional inequity of social hierarchy because females were comparatively nutritionally impoverished from the early occupation of the city. Haviland notes that the high degree of sexual dimorphism among the Maya is to some degree genetic. However, the social disparity among females that we have found indicates that middle-class females who occupied the intermediate domestic groups likely had more advantages than the women buried in lower-status domestic groups. Males do not show the same patterning, which suggests that the biological stress leading to growth disruption among male children was less systematic, less severe, or persistent at both levels of the hierarchy. Given that male growth is thought to be more susceptible to growth disruption (Brauer 1982; Stinson 1985), these results imply a considerable nutritional advantage or other forms of social buffering for males at Tikal that spanned from the highest to the lowest social strata. In contrast, the growth of low-status females was most compromised.

Figure 3.2 shows mean male stature plotted against mean female stature at Tikal for various chronological and architectural subsamples. The diagonal line is the reduced major axis from Holden and Mace's (1999) study of sexual dimorphism in a sample of 76 ethnographic populations and provides a frame of reference for the degree of sexual dimorphism at Tikal.

Both male and female Tikal statures lie at the short end of the modern human range. Subsamples above the line show a high degree of sexual dimorphism; male stature is considerably greater than female stature. The greatest degree of sexual dimorphism appeared in the Preclassic sample, followed by the Early Classic; the Late/Terminal and Postclassic samples showed less dimorphism. However, excavation sampling undoubtedly biases this, since the Preclassic burials are primarily from elite contexts. Small, low-status domestic groups from the Preclassic period are either deeply buried, and thus have not been excavated, or developed into larger intermediate-ranked domestic groups by Early and Late Classic times. It is interesting to note that the only skeleton from a small Early Classic group shows the shortest stature in the sample, 131.9 cm (PNT-113, female), though we resist the temptation to infer much from this observation. While

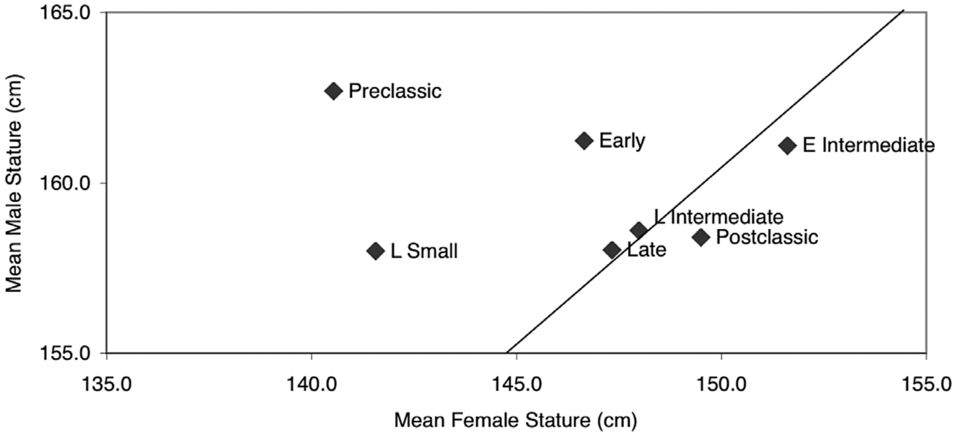

Figure 3.2. Mean male and female statures at Tikal, by time period and architectural context. The trend line is the reduced major axis from Holden and Mace's (1999) study of sexual dimorphism.

male stature may have declined slightly from Preclassic and Early Classic times to the Late Classic period, the higher sexual dimorphism seen in the small domestic groups is fueled instead by markedly shorter female stature in these low-status Late Classic contexts.

Paleodiet and Status at Tikal

Stable isotopic analyses of bone collagen provide a complementary means of interpreting stature variation in terms of nutritional hierarchies at Tikal that are also linked to individual skeletons, unlike archaeological measures of diet. The relative proportions of the stable isotopes of carbon (^{13}C and ^{12}C) reflect the relative contributions of plants that use the C_3 and C_4 photosynthetic cycles (O'Leary 1988). Since maize was the primary C_4 cultigen consumed by the Maya, stable carbon isotope ratios ($\delta^{13}C$) are usually interpreted as an index of maize consumption for the ancient Maya, although both terrestrial and aquatic meat sources also contribute to bone collagen $\delta^{13}C$ ratios. By contrast, stable nitrogen isotope ratios ($\delta^{15}N$) in bones are enriched in higher-trophic-level animals because of the fractionation of the stable isotopes of nitrogen, ^{15}N and ^{14}N, during protein digestion. Since both marine and freshwater fish in the Maya area are also rich in ^{15}N, $\delta^{15}N$ values serve as an index of meat and fish consumption (Ambrose 1993; Schwarcz and Schoeninger 1991; White and Schwarcz 1989; Wright and White 1996). However, data from patients with anorexia, together with experimental work on pigs, has found that growth faltering results in isotopic

enrichment of collagen $\delta^{13}C$ and $\delta^{15}N$ ratios (Mekota et al. 2006; Warinner and Tuross 2010). This would confound interpretations of dietary shifts. Thus, the effects of malnutrition on stable isotope fractionation deserve consideration when interpreting stable isotope ratios in archaeological remains.

We measured stable isotope ratios in the cortical long-bone collagen of 57 Tikal skeletons from the PNT excavations (Wright 2003). Seventeen of these individuals were also included in the stature sample. Neither $\delta^{15}N$ nor $\delta^{13}C$ patterns appear to be correlated with stature. Cortical bone remodels slowly over the lifespan, incorporating newly consumed nutrients. However, a considerable proportion of the collagen formed during adolescence is present in even older adult remains (Hedges et al. 2007). Thus, we might expect some relationship between stature and isotopic measures of diet if dietary composition is responsible for growth disparity in adolescence.

Figure 3.3 illustrates patterning in isotope ratios by sex, both chronologically and by architectural form (with time periods combined). There are no Preclassic males in the sample and there are no Postclassic skeletons of either sex. Neither $\delta^{15}N$ ($p = 0.86$) nor $\delta^{13}C$ ($p = 0.14$) show statistically significant sex differences when all periods were combined or within the Preclassic/Early Classic sample ($\delta^{15}N$ p = 0.25; $\delta^{13}C$ p = 0.96) or the Late/Terminal Classic sample ($\delta^{15}N$, $p = 0.48$; $\delta^{13}C$, $p = 0.15$). When the sexes were combined, $\delta^{13}C$ varied chronologically (ANOVA, $p = 0.07$ among Preclassic, Early, and Late/Terminal; *t*-test, $p = 0.04$ between Preclassic/Early and Late/Terminal). The Late/Terminal Classic skeletons were about one permil higher, perhaps indicating slightly greater maize consumption at the population maximum of the city. However, $\delta^{15}N$ remained stable over time (ANOVA, $p = 0.40$ among Preclassic, Early, and Late/Terminal; *t*-test, $p = 0.37$ between Preclassic/Early and Late/Terminal), indicating that meat consumption did not dramatically decline as the city's population grew. When analyzed separately by sex, a statistically significant chronological difference is seen in $\delta^{15}N$ for females only (ANOVA, $p = 0.04$ among Preclassic, Early, and Late/Terminal Classic samples); six Early Classic females (8.9 ± 0.8‰) averaged one permil lower in $\delta^{15}N$ than females in the Preclassic (10.0 ± 1.1‰, n = 4) or Late Classic (9.9 ± 0.6‰, n = 12) samples. The Early Classic females are from both small and intermediate domestic groups. This finding suggests some sex difference in protein sources or protein adequacy during the Early Classic period. However, the variation in $\delta^{15}N$ we observed in Late Classic females did not differ from that for males from the same period.

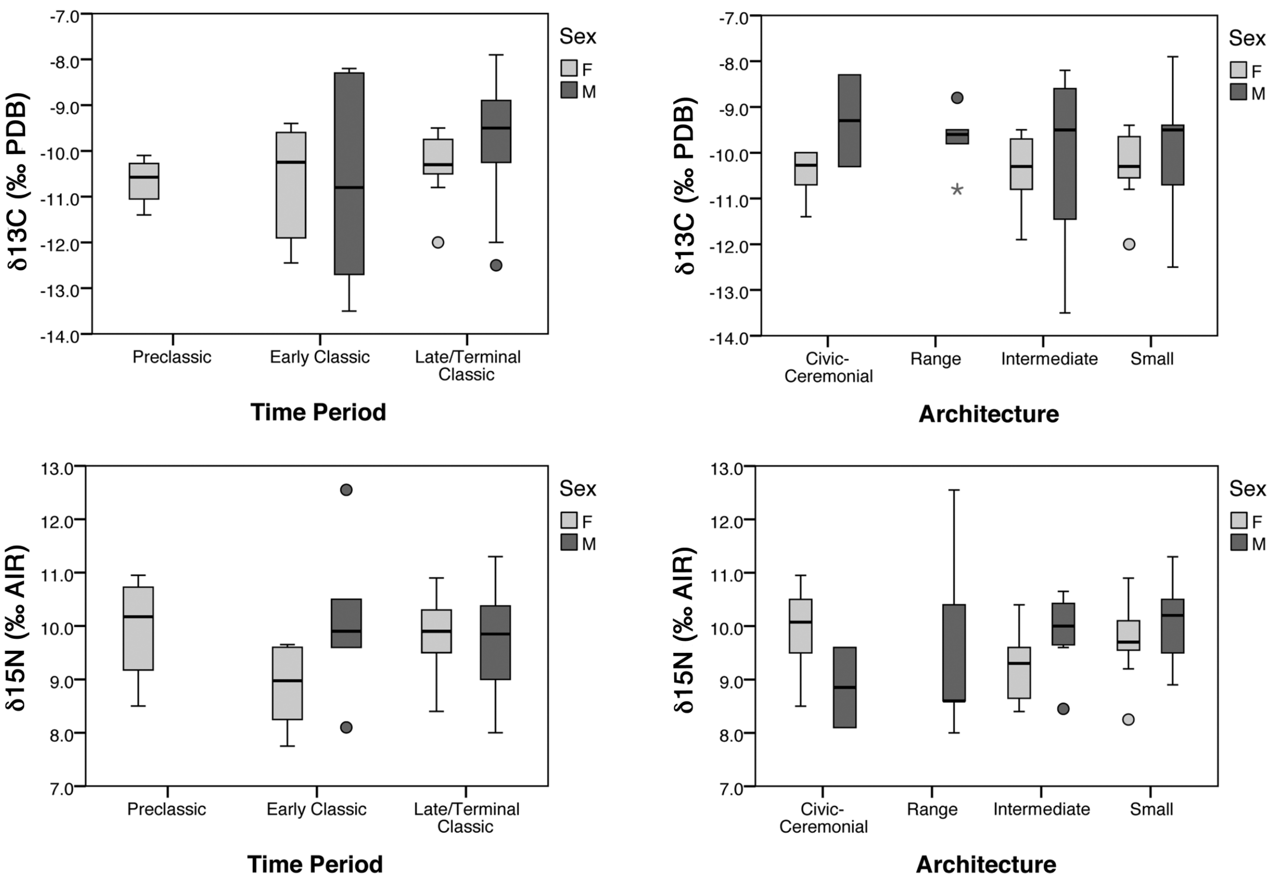

Figure 3.3. Stable isotopic ratios of bone collagen at Tikal by time period and architectural context.

An increase in maize consumption is consistent with archaeological reconstructions that propose a greater emphasis on maize monocropping that is associated with increased population density during the Late Classic period (Santley et al. 1986; Wiseman 1985). Zooarchaeological evidence suggests that Maya hunters shifted their focus to smaller game during this period, perhaps due to overhunting of large game by the large populations of the later Classic period (Emery 2007). This would not necessarily lead to an isotopic change if meat intake remained stable and this hypothesis is not inconsistent with the isotope data.

There are no statistically significant differences among males and females in either isotope ratio of skeleton among the different architectural group types. This is the case for both the pooled chronological sample and for comparisons of small and intermediate groups of the Late/Terminal Classic period and the Pre/Early Classic period. Yet when the sexes are combined, Late and Terminal Classic skeletons show a significant difference between small and intermediate domestic groups ($p = 0.02$): individuals buried in the small domestic groups had lower mean $\delta^{13}C$ values, indicating less maize consumption. It appears that the greatest sex difference in diet was among individuals interred in civic-ceremonial contexts. The males in that group have higher $\delta^{13}C$ values and lower $\delta^{15}N$ values than the females (Fig. 3.3) hinting at greater maize consumption by males and perhaps greater meat consumption by females, although this hypothesis is not testable because of our small sample size. These patterns may be somewhat counterintuitive. Although maize is not nutritionally superior to meat, it appears to have been a highly valued food at some other Maya sites, and this may be true especially under conditions of agricultural stress related to increasing population size (White et al. 1993). It is surprising that females show higher $\delta^{15}N$ in the civic-ceremonial contexts than males, though this may again be an artifact of small sample size. Another possibility is that elite females from distant sites who moved to Tikal at marriage could have retained the collagen signals of a nonlocal diet.

It is possible that chronological and social patterning in $\delta^{13}C$ and $\delta^{15}N$ at Tikal can be interpreted in terms of growth restriction rather than as evidence of dietary change, although both factors are undoubtedly at play and will be very challenging to disentangle. In view of the extremely short stature of females in small domestic groups, the higher $\delta^{15}N$ of small-group females would be consistent with stunted growth attributable to dietary insufficiency rather than to a difference in the composition of the diet. Although the stability of male stature in our sample is remarkable, the slight

increase in $\delta^{13}C$ in later periods of occupation could perhaps likewise be attributed to growth deficit.

Conclusion: Stature, Diet, and Hierarchy at Tikal

Our study wrestled with many of the same challenges that Haviland (1967) encountered, especially small sample sizes during the earlier occupations of Tikal. The scarcity of the highest elites in our sample also influenced our findings. Our larger sample size for females and the use of sex-specific stature regression equation for females (Genovés 1967) makes the female data somewhat more reliable. Use of reconstructed bone lengths increased our sample size, but this methodology also introduces some degree of error, not unlike the use of in situ measurements.

Although the specific findings of our study do not match Haviland's (1967) results, the big picture is not dramatically different. Stature may have declined slightly among middle- and lower-status males over the span of Tikal's history, perhaps indicating subtle change in nutrition over time. Stable isotopic ratios in bone collagen support this picture of dietary stability. Although slightly greater maize consumption in the Late Classic (perhaps mostly by males) might suggest agricultural stress, it was not paralleled by a dramatic drop in meat consumption. On the contrary, it appears to have been accompanied by an improved protein intake for Late Classic females. However, a competing interpretation—that the increase in female $\delta^{15}N$ is a product of stunted growth—is equally plausible. Together, the two data sets raise the possibility that the stature decline Haviland described might apply primarily to those at the highest status level of Maya society, a group that was largely absent from our sample.

We found evidence of stature differences among social strata to be more subtle than Haviland (1967) first described. Although we found no stature differences among different grave facilities, our results for females alone parallel the patterning he described among burials in low- and middle-status housing (Haviland and Moholy-Nagy 1992). Females in intermediate groups also stand out as having low $\delta^{15}N$ during the Early Classic period, which presumably indicates a sex difference in protein sources in this status level. The fact that intermediate-group females were taller than small-group females but showed lower $\delta^{15}N$ is a compelling reason to suspect that growth disruption may indeed have influenced the isotopic ratios. Maya children today also show considerable growth stunting due to chronic undernutrition. The short stature and high sexual dimorphism of the modern

Maya is a result of the fact that while Maya girls mature earlier than Maya boys, they grow at a slower rate than that of their male counterparts. Thus, Maya girls attain a shorter adult stature than Maya boys, for whom adolescent growth is slow and maturation is delayed (Bogin et al. 1992). A similar mechanism may have been at work at Tikal.

Additional evidence of childhood growth disruption, such as enamel hypoplasias and Wilson bands, may help clarify social and chronological patterning in diet at Tikal. Carbon isotope data from tooth enamel, which is formed only in childhood, may correspond more closely to dental evidence of growth disruption and indeed stature, since early childhood deprivation influences final stature. Ongoing work with the Tikal remains will incorporate these data to further examine growth and nutritional stress. For the ancient Maya, however, our findings confirm Haviland's conclusion that the occupants of Tikal lived in a hierarchical society, in which access to nutritional resources was unequal (Fried 1967). This inequality appears to have developed by at least the Early Classic period, though the strongest evidence of nutritional and sex-based inequality is found in Late Classic times.

Acknowledgments

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4

Spytihněv I (CE 875–915), Duke of Bohemia

An Osteobiographic Perspective on Social Status and Stature in the Emerging Czech State

MARSHALL JOSEPH BECKER

The recognition that human stature reflects physical well-being and nutrition led Danish social planners to incorporate this observation into their evaluations of social planning policies over a century ago. Masali's (1967) observation that better nutrition is linked to an *aumento seculare* (secular increase) in stature came to be seen as useful for social planning throughout Europe. Studies of northern Italians during and after World War II (Masali 1967) and of Sicilians, the latter of which was based on stature data extending back to 1850 (Cappieri 1963), seemed to confirm Masali's finding. Correlations among stature, social class, and the health of the living (Steckel 1994, 1995) now are commonly used to track regional economic trends. Nicholas and Steckel's (1991) regression analyses of these data have revealed urban-rural and regional variations in these biological consequences of socioeconomic processes.

During the past few decades, the study of the relationship between stature and social class, now identified as "auxology," has become a significant tool in the study of social and economic history (D'Amore et al. 1987; Schell 1986; Singh and Harrison 1997). More recently, these studies have been used in efforts to understand social history, including transitions from complex chiefdoms to early states. The relationship between nutrition and variation in stature has been used to evaluate status differences within archaeologically known ancient chiefdoms in North America (Powell 1988) and elsewhere in the world. This biological approach parallels the evaluation of mortuary complexity as an indicator of differential status (Robb et al. 2001; see also Sellevold 1994 for Medieval Norway). These discoveries do not tell

us why any individuals have greater status, but they generally confirm that higher rank correlates with greater quantities or quality of grave goods. By inference, we believe that taller individuals had greater access to higher energy or protein food resources as part of their status ranking. Possible confounding factors have been summarized elsewhere (Becker 1999, 227) and are noted by many of the contributors to this volume, but in general, we expect that stature will correlate with social rank.

A window on social status and stature in an emergent European state can be opened through the study of human remains recovered from excavations immediately west of the Cathedral of St. Guy in the center of Prague. This work revealed a largely complete foundation of the small Church of the Virgin Mary (Kostel Panny Marie, built ca. 882–885 CE), which is buried under one of the many later buildings that now form the vast Prague Castle complex (Fig. 4.1).[1]

Within that small Christian structure, which is almost as small as a chapel niche of the huge cathedral that now dominates Prague Castle, was a small chamber tomb (Fig. 4.2) in which were interred the body of Prince Spytihněv and his wife and the skull of a second woman. The bones of these two royals provide the basis for the consideration of their stature and how it relates to their status in Bohemia at a time when it was an emerging central European state.

Background

During the late ninth century, several states were forming in Europe. The beginnings of the Přemyslid dynasty of Bohemia established the foundations of the early Czech state, which later emerged as one of three great powers in central Europe (Bohemia, Hungary, Poland). The core of the Bohemian region was along the Moldau in the area that has become modern Prague, situated at the center of modern Bohemia, the western province of today's Czech Republic. These evolving states emerged from complex historical trajectories influenced by the shift from Roman military control and Roman-oriented trade to independent but church-influenced polities. This transformation was part of a widespread process of political development throughout central Europe (see Bührer-Thierry 1997). The combination of archaeological findings and archival data reveal the many complex processes involved in medieval state formation in Bohemia (Bubeník 1994a, 1994b). The importance of skeletal studies of the emerging elite in Prague is

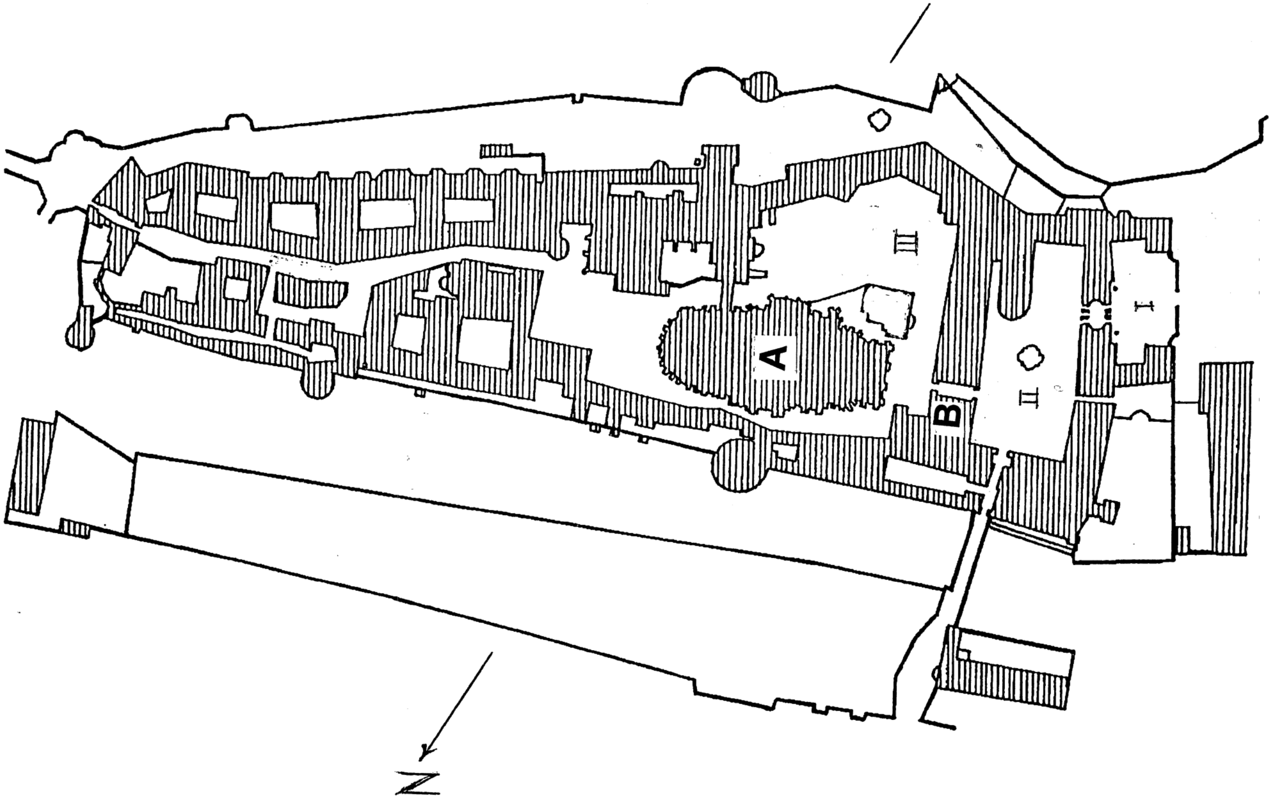

Figure 4.1. General plan of Prague Castle. The locations of the three principal courtyards (I–III) appear at the western end of the complex. A: Prague Cathedral (Cathedral of St. Guy). B: Carriageway connecting Courtyards II and III. From this passage the foundations of the Church of the Virgin Mary are now visible. Adapted from Frolík 1988, Fig. 1.

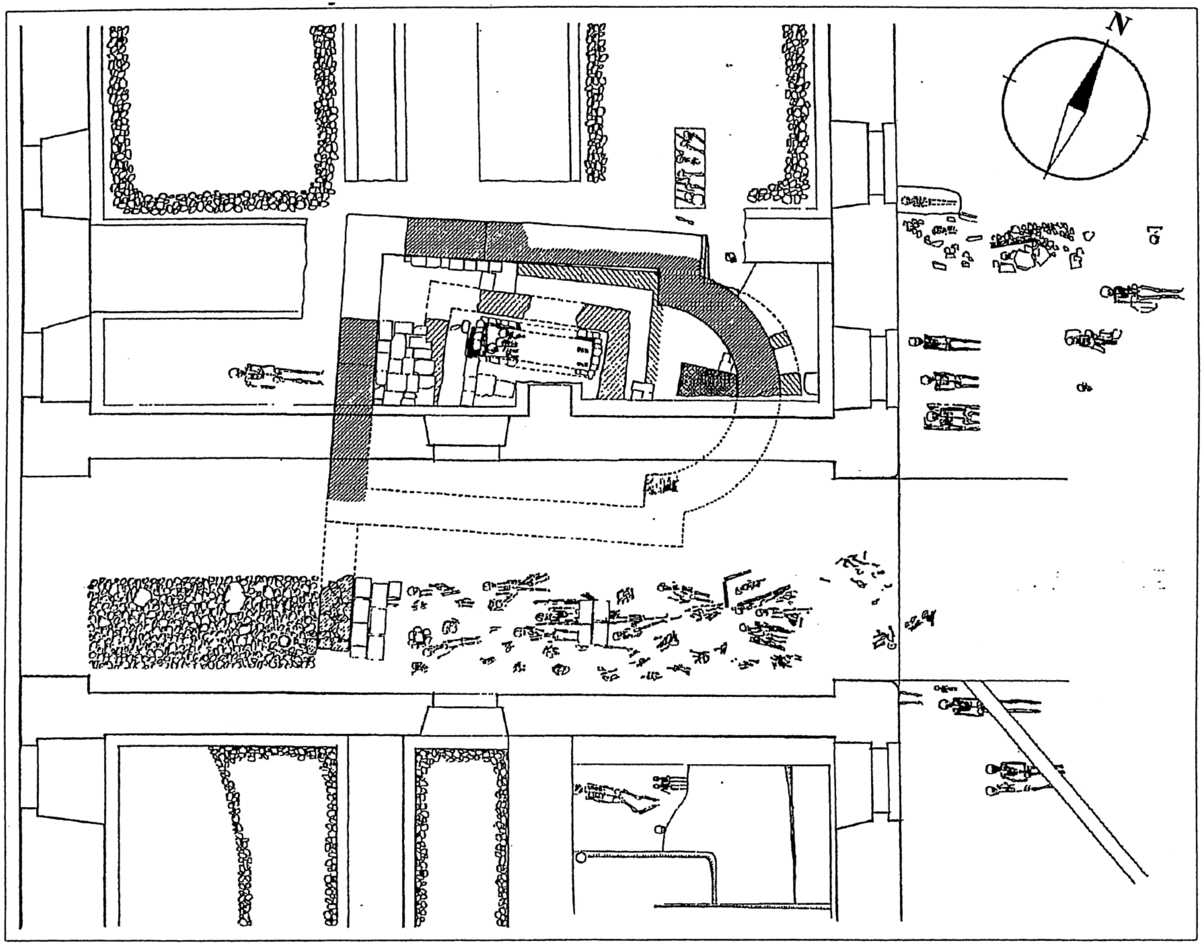

Figure 4.2. Detailed view of the location of the foundations of the Church of the Virgin Mary, with the tomb of Prince Spytihněv I. Adapted from Frolík et al. 2000.

increased by their value in evaluating parallel processes throughout Europe (Kubková et al. 1997).

In 870 CE, Bořivoj I (ca. 852–889) became the first Bohemian ruler of what became the Přemyslid dynasty (870–1306). At that time, the duchy was under the control of the Moravian princes. Bořivoj declared himself *kniže*, or sovereign, a term generally translated as "duke" or "prince." On Bořivoj's death, Spytihněv, his eldest son, who is generally believed to have still been a minor, became his heir. By 895, Spytihněv I had become the ruler and had established his realm free of control by the Moravian princes.

The archaeology of the medieval period in Bohemia has a long and productive record (see Klápště 1994). Even the early archaeological research programs in the early 1900s involved considerable efforts to recover and study human skeletal remains. Descriptions of the physical characteristics of the population at the center of the Czech state, especially of the elite social strata, may help elucidate the complex social interactions between rich and poor and possibly between the growing urban population and their rural neighbors in the region surrounding Prague.

The events surrounding the people whose skeletal remains are the focus of this study are related to the history of the region generally identified as Greater Moravia. The origins of the settlement area of early Prague, within what had been the ancient Bohemian polity, are becoming clearer each year as archaeological work progresses at an unprecedented pace (Frolík 1994; Tomková 1997). As Bohemia is mainly served by the Vltava (Moldau) and Elbe (Labe) Rivers, wide-ranging settlement research conducted throughout their drainage areas offers impressive data for comparative studies. The skeletons recovered over the many years of excavation, especially during recent work under the direction of Jan Frolík (head of the Department of Archaeology at Prague Castle), provide extensive and very well-preserved bodies of biological data from throughout the area inhabited by the lineal ancestors of the modern Czech people. These vast skeletal samples from sites throughout the country have been carefully preserved and are easily accessible for study. The sample discussed here is one of the smaller collections from the vast necropolis-like region below and around the present walled area that is identified as Prague Castle. Many of these "cemetery areas," which are largely defined by efforts at recovery preceding construction, have yielded remains of several hundred individuals. The earliest burials appear to date from the seventh century and the latest may date from the 1800s. In the Lumbe Garden area and elsewhere outside the walls of the Prague Castle, burials of an early period of interment have been exten-

sively disrupted by graves dug several centuries later. My research program, which involved at least one month of study each year for ten years, was focused on age and sex evaluations in support of archaeological studies of these graves. The published data from these studies (Becker 2000a, 2003) is but a small fraction of the information gathered. The remainder can be found in manuscripts filed with the Czech Archaeological Service.

Goals

The analysis of the human skeletal remains recovered from the area in and around the Church of the Virgin Mary was part of a much larger project to understand how the grounds of the Prague Castle area were used in antiquity. The overall program has been detailed elsewhere (Becker 2000a, 289–290). The specific focus of this chapter is the remains of Spytihněv I, the remains of the woman believed to have been his wife, and fragments of a second and much younger woman. Although status markers in royal tombs have been widely examined in the Maya realm (Krejci and Culbert 1995; and Źrałka et al. 2011) and in late pre-Hispanic Peru (Klaus, Shimada, Shinoda, and Muno, this volume), they have rarely been applied during the period of emerging states in central Europe.

The data on age and sex (and incidentally on stature) were not driven by specific hypotheses at the time of collection. Only later was this information applied to a number of questions of general interest to anthropologists. In considering the evolution of the Czech state, we thought that comparing the achieved stature of these two elites with those of the general population of that period that was buried in the immediate vicinity might reveal the biological consequences of higher status in the emergent Czech state. Documenting an elite group with greater stature than the general population during this period of political change enables us to view correlated social changes. Stature could, therefore, serve as a proxy that indicates emerging and continuing social stratification.

Materials

During the early medieval period, the residential area at Prague Castle was located to the east of this burial ground, but over the centuries, much (if not most) of the entire high area was used as a cemetery. The area of the Prague Castle from which the bones in this study have been recovered was not a simple and bounded "cemetery" area in the commonly understood

sense. Both ancient and many relatively modern cemeteries have patterns of growth and development that tend through time to create "disorder" below ground. Even the most precisely laid out funerary spaces experience changes and problems that cause later graves to be cut into earlier graves, but this usually does not happen until after the passage of a century or more. While no fixed interval of time can be assigned to this process, more than forty years of my personal excavation experience in the recovery and analysis of skeletal materials from more than forty-five ancient cemeteries of all periods (Bronze Age to the 1920s) indicates that after about 100 years of use, confusion in body placement becomes common. Very often, older parts of cemetery areas become subject to reuse after only a few generations. Grave pits and constructions for burials, other types of construction, land contouring and normal changes in topography, and other factors account for the fact that newer graves intrude upon older ones. This process is vastly accelerated in urban contexts, despite the surface appearance of what seems to be an "orderly" cemetery through regular rows of tombstones, plot markers, and other constructions that suggest the presence of organized rows of graves.

The reality is that most cemeteries that are in use for more than a century soon come to resemble the situation that has been discovered through excavations in the Courtyard II of the Prague Castle (Fig. 4.1). Large numbers of graves had been cut into and through earlier graves that in turn had been cut into even earlier graves. The result is considerable disruption and general destruction of the graves that predate the most recent ones and the corresponding loss of skeletal order and data. In addition to the many "intact" graves excavated from the area of the Church of the Virgin Mary, the numbers of fragmentary remains recovered from these contexts indicates that this burial area was used from the eighth through the thirteenth centuries. Later graves frequently were dug through earlier interments, disturbing the skeletons of the earlier inhumations. This behavior, which is common wherever cleared land resources are highly valued and/or space allocated to cemeteries is well defined and restricted, appears to have happened at the Prague Castle. This accidental reuse of burial plots also indicates little or short-term marking of individual graves over long-term use of the area.[2]

Different excavators at Prague Castle, working at different times within the past century (Hillbert 1911; Smetánka et al. 1980; Smetánka and Frolík 1986) have had an increasing focus on the recovery of human skeletal remains. As a result, we have as many as three separate collections of bones

from any one specific location, such as the area to the east of the apse of the cathedral or in the area of Courtyard II. Since each excavator had different constraints on their work, the configuration of the excavated units was never the same. Fragments of bone from different excavations and different target areas had to be identified and matched in a labor-intensive process.

Excavations in the carriageway between the second and third courtyards and the general area surrounding the Church of the Virgin Mary conducted between 1930 and 1995 recovered human remains that represented a population of the ninth to thirteenth centuries or later. In 1930, archaeological work during renovations of the carriageway identified a series of early graves and remains from disturbed interments (see Becker 2000a, 348–350).

The project discussed here focuses on the human remains interred within the tiny Church of the Virgin Mary, the second Christian structure built within the present Czech Republic (Frolík et al. 2000). The bones from this context were identified from the historical record as those of Spytihněv I, Duke of Bohemia, and his wife. They had been interred within this small structure at a general period in Christian history when burials were first being made within churches (Becker 1997). Previously, Christian burials were only made outside and around religious structures, which commonly were erected (or converted to use) in non-urban locations. During the ninth century in northern Italy, the earliest evidence of interments of elite or high-status individuals are found within small, chapel-like churches (Becker 1997, 2000b).

The study of the remains of Prince Spytihněv and those buried with him was part of a skeletal research program that was initiated in August of 1997 in order to understand mortuary activities at a location now within Prague Castle. This particular area was the focus of excavations in 1995 associated with construction in the carriageway connecting Courtyards II and III, around the west end of Prague Cathedral (the Cathedral of St. Guy, also identified as St. Vitus, construction of which was begun ca. 1300 CE; see Frolík et al. 2000). These bone studies were part of a larger effort to review Early Medieval human skeletal remains recovered during excavations from a number of locations within the Prague Castle. As early as 1911, extraordinary archaeological efforts focused on salvaging evidence of the past of Prague Castle. A century ago the impacts of construction or modernization were seen as an opportunity to explore the rich cultural history at this site.

Methods

The formulas Trotter and Gleser (1952, 1958, 1977) devised for Euro-American males and females were applied in the estimation of stature. The multiple nonstandard methods of analysis commonly used to evaluate commingled remains were applied in this general study (see Becker 2000a, 342–346). While my focus here is on data related to stature, of particular note for the history of the Czech Republic is the calculation of the age at death of Spytihněv I. A number of details reflecting geriatric characteristics were involved and have been listed in detail in the published report. In almost every case for which stature has been calculated for individuals in this population, only one or two intact long bones survive. In one case where I believe we have a sample from both upper and lower limbs, the results of the calculations led me to question the relative proportions (allometry) as they relate to these calculations of stature.

Results

Human Remains from the Courtyards

The now open areas of the several courtyards formed by extensive building activity to the west and southwest of Prague Cathedral provide access to the vast archaeological materials below. The standing buildings, one of which now covers the remains of the Church of the Virgin Mary, are only the most recent manifestations of centuries of construction activity within the present confines of Prague Castle. Not surprisingly, the 1930 carriageway excavations revealed only a few relatively undisturbed burials. Also found was evidence of a significant number of disturbed graves. Borkovský (1949, 69) assigned 14 grave numbers to units that he correctly perceived to represent individual burials. He also recognized that perhaps 30 to 40 people might be represented in this small area alone if individuals from disturbed contexts were included. Subsequent study of the skeletal material (Becker 2000a, 353) revealed that Borkovský was correct and that at least 8 adults and 20 subadults could be recognized among the assemblage that had been commingled for storage. Half of these 28 individuals probably derived from graves of earlier dates that had been largely obliterated by later interments and by construction activities. A review of all the human remains indicates a minimum number of individuals of 99 (see Table 4.1).[3] As indicated earlier, this mortuary situation is typical of the massive disruptions seen with

Table 4.1. Age and sex distribution of the Courtyard II sample

Age Group	Males	Unidentified	Female	Totals
Fetus		1		1
0–6 months		5		5
6.0–12.0 months		3		3
1.1–2.0 years		9		9
2.1–3.0 years		4		4
3.1–5.0 years		9	4	13
5.1–7.0 year	1	6		7
7.1–10.0 years		6	1	7
10.1–15.0 years	1	1	2	4
15.1–16.9 years		1		1
Subadult subtotal	2	45	7	54
17.0–20.0		1		1
20.1–23.0	1			1
23.1–25.0				0
25.1–30.0			1	1
30.1–35.0	1			1
35.1–40.0	1		3	4
40.1–45.0	5	2	10	17
45.1–50.0	2		1	3
50.1–55.0	2	1	1	4
55.1–60.0	1			1
60.1–65.0	1		4	5
65.1–70.0	2		2	4
70.1–75.0	1		1	2
75.1–80.0			1	1
80.1–85.0				0
Adult subtotal	17	4	24	45
Totals	19	49	31	99

cemetery reuse and with the later construction activity in the central area of Prague Castle. This is the case in both urban and rural cemeteries around the world.

Salvage excavations in the immediate area of the Church of the Virgin Mary in 1946, 1950, 1955, and 1995 (Becker 2000a, 339–340) encountered similarly problematical sequences of burials. Excavations in 1950 of the areas designated as Courtyard II (see Fig. 4.1) encountered a number of grave cuts from which skeletons had been removed and curated during previous work in this area. The human remains from these locations attracted less interest than those of the royal family found nearby. The site of the small Church of the Virgin Mary was located during the 1950 field season. Archaeologists identified the remains believed to be those of Prince Spytihněv I in the tomb chamber within the foundations (Unit 13253: see Becker 2000a, 310–311, 342–347; and Smetánka et al. 1983).[4] The large tomb that fills much of the excavated floor area within the foundations of the Church of the Virgin Mary actually yielded the remains of three individuals. Two of these are believed to be the prince (or duke) and his wife (Vlček 1997). The extremely limited historical documents surviving from that period do not reveal her name.

The 1995 re-excavations of the graves located in 1950 recovered a surprising quantity of small bone fragments. This newly retrieved skeletal material was of use in providing archaeological confirmation of the locations of these earlier excavations by joining fragments with bones found during the 1950 excavations. Similarly, small pieces of skeletal material (i.e., ribs and skulls) were recovered from the royal tomb through sifting of the matrix in 1995. In August of 1997, I was asked to examine these fragments and determine how they related to the bones Prof. Vlček had studied.

Note should be made that both royal skeletons had been damaged by much later construction activity, possibly the construction of a trench. That activity, which took place centuries after the tiny church of the Virgin Mary had decayed and been "lost," destroyed or displaced the bones of both royals from just below the thoracic vertebrae to the tarsal bones. Fragments of the royal couple displaced by this later building process may have been mixed within fills and layers dating from long after the dates of the original interments. None of the small quantities of human bone that were identified in the later excavation lots in this area, however, were conclusively identified as derived from the royal couple.

Only two graves were encountered during the 1955 excavations. In fact, these archaeological units identified only clusters of human bones that in

the field were believed to represent an adult (Unit 13462) and a child (Unit 13463). Osteological evaluation of the remains in Unit 13463, however, revealed that the bones identified as a child included portions of at least five people, two of whom were adult females (Becker 2000a). Some fragments from Unit 13462 were found to join with bones in 13463. Since both principal women (the most complete representation of bones within the unit) are represented by at least part of a right ulna, these three long bones are probably placed with the appropriate skeletons. A summary of the data relevant to the present study follows.

> 13462: Female; age 70 ± 10 years; stature 157.0 cm
> Three bones from this unit are intact or could be reconstructed to their complete length from which stature could be calculated:
> Left femur = 398 mm (152.406 ± 3.72)
> Right ulna = 245 mm (162.374 ± 4.30)
> Left fibula = 331 mm (156.357 ± 3.57)

These data are interesting because the calculated stature estimations for the femur and fibula fall beyond the error range for the ulna. This might suggest that more than one woman is represented. The statures calculated from the leg bones are in good agreement. If we assume that only one woman is represented by all three bones and that the fibula-ulna differences overlap, one may infer that this woman had relatively long arms. The tall stature calculated for the woman in Unit 13463 (see below) derived entirely from measurements of the arm bones. Whether she also had relatively long arms remains unknown, but the similarities suggest that these women may be closely related and are from the same population.

> 13463: Two young women and three children, identified as 13463A–13463E (see Becker 2000a):
> 13463A: Female; age 26 ± 5 years; stature 166.5 cm ± 1 cm
> Stature calculated from two upper limb bones only
> Right humerus = 322 mm; stature 166.162 cm ± 1 cm
> Left radius = 236 mm (estimated); stature 166.794 cm ± 1 cm

Results of the Skeletal Study of the Tomb of Prince Spytihněv I

This impressive collection of skeletal remains from Courtyard II, which possibly represents an urbanizing if not an elite population of Prague during the important centuries when the early Czech state was forming, provides a useful sample for comparison with the bones of the royal family

(Vlček 1997). Ancient mtDNA from the bones of several royal dynasties can be compared with these individuals to determine their internal kinship relationships. They can also be compared with royal descendants and with royal families of central Europe (see Flury-Lemberg and Otavsky 1994).

Prince Spytihněv I and His Wife

The review of the bones of the prince and his presumptive wife was conducted as a double-blind study without consultation with either the historical record or with the results of Vlček's (1997) more detailed examination. The brief study that resulted, therefore, provides us with a second opinion that can be useful in interpreting the skeletal record. The findings from this brief reexamination are summarized here from the more complete report (Becker 2000a, 342–346). Of particular interest was the determination that the prince was about 65 years old when he died, some 25 years older than historical speculation. Since the historical record of his transition to power suggested that he was a child, this new evaluation requires a reevaluation of the sparse historical record. Vlček's (1997) evaluation of the skeletal record led him to propose an age at death of "41.7± 4.6 years," which curiously conforms with popular historical beliefs. Subsequent to my publication of a very different figure (Becker 2000a, 342–346), two teams (Brůžek et al. 2002; Sláma 2001) reviewed the evidence but did not contradict my evaluation.

Prince (Knize) Spytihněv I

Robust male; stature 178.383 ± 4.57 cm

The historical record suggests that Spytihněv I died at an age of about 40 years. My study of the bones of this massive male suggested a person who died at approximately 65 years of age. Dental wear suggests an age of only approximately 55 years, but all other features of the skeleton indicate an older individual (for the study of the dentition, see Becker 2000a, 342–343). For example, the spines on the right calcaneus suggest an age of 65+ years. Cranial suture closure suggests an age at death closer to 70, but suture closure rates have wide variability and therefore less accuracy in age evaluations.

The duke's skull is largely intact but has been heavily restored. The morphology of his skull attests to his impressive robusticity, which is confirmed by his prominent supraorbital tori and all metric indices (see Table 4.2, also Becker 2000a). A most interesting feature of this skull is on the right side of

the occipital bone, lateral to the midline. A circular depressed area (diameter 27 mm) at first glance appears to be a completely healed trepanation (cf. Becker 2003). Of interest is a slightly raised ring of bone surrounding the area of reparative bone formation. Thin pieces of the regenerated bone are missing, having been lost after death. Slight irregularities in the border of this feature hint at the possibility that this is the result of a blow with a round or pointed object or some other injury that predated his death by perhaps three to five years (see Arnott et al. 2003). Given the area of the skull where this feature is located, it is doubtful that the prince would have survived a penetrating blow from a long pointed object, although people frequently have been known to survive extensive cranial injuries. Damage from blunt force cranial trauma is more likely.

Of particular interest is the presence of the lateral incisor trait (see Pinto-Cisternas et al. 1995) on both the central and the lateral incisors. This feature is common among the Etruscans and throughout central Italy and is evident to a lesser extent at the extremes of the peninsula. It has not previously been reported from beyond that part of the Mediterranean, but by normal genetic distribution its presence is not unexpected.

As noted earlier, the central parts of the extended skeletons of the prince and his wife were cut through their centers by building activity. Thus, both are represented by elements of the superior skeleton and an assemblage of leg and foot bones that have been "matched" with the upper bodies. The only intact long bone of the prince is his left humerus, from which the length (347 mm) has provided the evaluation of stature (see discussion). Asymmetrical differences in robusticity of his long bones suggest that the Duke was left handed.

The Princess (Spytihněv's Wife, Name Unknown)

Robust female; age 50+; stature 159.106 ± 4.45 cm

The conservation process used with the skull has made measurements difficult, as the mandible has been affixed to the maxilla. In addition the long, thin face of this woman has been exaggerated by distortion that probably took place in the ground but now has been emphasized by the reconstruction process. This problem also should be noted for all of the skulls that are described in this report and was a factor that led to the decision to leave metric evaluations to another time.

Third molar agenesis was common in this population, but all 32 of this woman's teeth had erupted. Of note is the loss of one tooth before death; the

maxillary right central incisor. This is an unusual tooth to lose. While some analysts might postulate that this was the result of a violent blow to the face, I believe that it may reflect deliberate ablation (see Robb 1997; cf. Becker 1994, 1995a, 2000c). This woman has the same narrow central and lateral incisor mesiodistal dimensions, that is noted for the prince and is common within this Bohemian population. Dental wear suggests an age of 45–55 years, but social status might be considered an influence on this observation as her association with the prince may have provided a more refined diet and thus less dental wear (cf. Molleson 1994). Whether the elites of this period in Bohemia consumed a less coarse diet than commoners did has yet to be studied. Cranial sutures externally are obscured, but the internal sutures may indicate an age of 40–50 years, with a wide error range around these figures. The general lack of geriatric characteristics suggests that she died between 50 and 55 years.

Several traits on the skull are important for determining the origins of this woman. Very interesting is the full metopic suture, which had completely fused. An area surrounding this portion of the frontal bone had been broken off but now has been restored. No evidence can be seen of the lateral incisor trait. Both parietal foramina seem to be patent. A small ossicle appears at lambda in addition to two small examples in the left leg of the suture and at least one in the right. These seem fused and largely obliterated, if not obscured by the coating now on the bone. An interesting aspect about this facial structure is the slight nasal (left) guttering, a feature more common in North Africa and to the south.

Individual Number 3 in the Prince's Tomb

This identity of this female, aged 20–36 years, is unknown. She is represented only by the vault of her cranium. No postcranial remains can be specifically related to this woman, who is much smaller and less robust in every way than the prince's wife. The cranium of the second female in this tomb context is interesting (cf. Cucina and Tiesler 2006) but not as suggestive as some would like to think. The relationship of this individual to the prince and his wife lead to some interesting possibilities.

Photographs (see Vlček 1997) reveal that this cranium was situated toward the southwest corner of the tomb and was sited at a higher elevation than the heads of the royal couple. This suggests that it may have been added at a much later date. Most likely it represents the disposal of a cranium that had been disturbed from a grave somewhere in this general area and was deposited in this tomb. A third possibility is that it was from a

grave disturbed in the building of the small Church of the Virgin Mary and that the cranium was left inside the structure and later placed within the tomb. Her small size suggests that she is not a daughter of the royal couple who may predeceased her parents (but see Becker 1993). She might represent Ludmilla, mother of Spytihněv I, but this is purely speculative.

Discussion

The human skeletons buried in the area around the tiny Church of the Virgin Mary, as is the case for those buried around the Cathedral of St. Vitus, are almost entirely those of ordinary people. Grave goods are rare. An unusual exception that was excavated in 1926 comes from the area between the ancient Royal Palace and the Cathedral of St. Vitus. A thirteenth-century metal chalice and two bronze rings suggest a possible priest's grave (Frolík 1988). This late and deeply intrusive burial disturbed many earlier graves of commoners (Becker 2000a), whose bones provided much of our study sample. The recovery of the remains of two early members of the Přemyslid dynasty of Bohemia and numerous graves of other early residents of Prague offered direct evidence for comparing stature in this ninth-century population. Other studies have provided evidence that higher-status individuals experienced better health than their subalterns (Chapter 1). In their review of the skeletal evidence of the bioarchaeology of social complexity, "terminal adult stature" is among the categories the editors of this volume list. While I have reservations about status variations in many of the categories on this list, such as enamel hypoplasias, the available skeletal sample provides a means by which each may be tested. Here I offer data on one variable from one cemetery area within the area of Prague that includes Prague Castle and the surrounding high ground.

The impressive and important hill fort that evolved into the present Prague Castle has a number of burial areas. Several are now relatively well known through excavation. Some of these areas, such as the Riding School cemetery, include burials that date from occupational periods that can be relatively clearly placed in time through the presence of grave goods. The general area surrounding the Church of the Virgin Mary appears to have been used as a burial area since at least the end of the ninth century until the thirteenth century, possibly with some breaks or periods when no burials were made. Unfortunately, a nearly complete absence of grave goods and the churning up of the soil through constant reuse of the area have reduced the possibility of accurately dating these graves. The dates of in-

dividual graves and even of clusters of graves cannot be determined with precision.

The human remains from the skeletal population from the part of Prague Castle that is the center of this study, the courtyard zone in the area of the Church of the Virgin Mary, are limited in number due to later construction that now covers much of the area (see Fig. 2). The few bones that have been recovered had suffered extensive but entirely expected damage while in the ground due to their location at the center of an active area of building and renovations. Numerous other cemeteries throughout Bohemia have yielded impressive quantities of skeletal material that are well preserved and have been carefully recovered and stored. Nevertheless, the largely fragmentary bones from the area around the Church of the Virgin Mary provide some important clues to physical characteristics and biology of the people of the early Czech state.

That excavation also identified 22 relatively intact graves in Courtyard II in addition to the three adults represented in the princely tomb (Unit 13253). We cannot discount the possibility that the third person within the tomb, represented only by a partial cranium, derives from one on the many disturbed tombs noted nearby or perhaps from the location within the small church where the tomb was dug. Detailed examination of all the skeletal remains recovered from the area indicates that far more than 22 people had been buried at various times in this general location. A minimum number of 99 different individuals (based on the count of mandibles and left tibiae) now can be recognized from the bones recovered from the various excavations in the area of Courtyard II, the region immediately around and including the Church of the Virgin Mary (Becker 2000a, 337–349, Table 4). The bones from the earliest modern excavations in 1930 were combined into a single box for storage. Study of these commingled remains provides evidence of the presence of at least 28 people. The later archaeological excavations that identified units relating to skeletons can be grouped into approximately 55 additionally distinct individuals (27 from the 1930s; 19 from 1950; 2 from 1955; 7 from 1995). A primary goal of this skeletal study was to reassemble the remains from individuals whose bones may have been disturbed prior to this century and then recovered during these several periods of excavation (Becker 2000a, 337–340).

The Lumbe Garden Cemetery burials (see note 2 below), which date from approximately this same period of time, also have one person in each burial. In fact, the placement of the duke and his wife within the same tomb may be considered anomalous. Although the placement of couples side

by side is not rare, placement in the same physical grave is uncommon. I have found that pairing in single graves is common in only one location, medieval tombs from the area of Knossos on Crete (Becker 2005a). The unusual placement of the presumed wife of Spytihněv I in his grave should be considered when attempting to identify this woman.

An important observation is that the average stature of the women in this sample is much greater than I would have expected. From the courtyard area Unit 13382A, one woman's average adult stature has been calculated at 166.3 cm, the tallest in the sample prior to the 1999 identification of a female (13463A) with a stature of 166.5 cm. These findings are of particular interest when the results are compared with what has been published about Prince Spytihněv I and his wife. The impressive skeletal robusticity of both the prince and his wife speak to a diet and lifestyle quite different from those of the people buried around them. However, their respective statures are not at the top of the charts compiled from this study (see Table 4.2). This finding of the statures of the prince and his wife is also interesting because is similar to Molleson's discovery from a Romano-British site that principally dates from the period 300–400 CE. Molleson (1992, 44, 46) notes that although there is remarkable uniformity in the stature of that local British population, in the few excavated high-status "mausolea, some of which were used for the burial of members of a family of extraordinary physique," a clear divergence was evident. This same phenomenon seems to characterize Spytihněv and his people in Prague.

The data that are available from the bones of Prince Spytihněv I and his family provide a possible basis for confirming biological studies relating to social class and status (see Lasker and Mascie-Taylor 1996). While the prince and his wife were relatively tall within the range of males and females from this population, they were not the tallest individuals in this sample. The prince may have been descended from a line of chiefs, but formalities of royal marriages may not have been established by this time in Bohemia. This is suggested by his wife's stature, suggesting a possible marriage not based on status. Whether the stature of the royal family increased through time, as would be predicted by Lasker and Mascie-Taylor (1996), or remains within the normal range, as appears the case with these first members of the Přemyslid dynasty, is an interesting question to be explored in the future. Future studies also may consider if these characteristics of stature differences among various social classes may be useful in distinguishing the population of Bohemia from others and thereby help in the construction of cultural borders in antiquity.

Table 4.2. Metric measurements (in millimeters) from the three skulls in the tomb

Measurements[a]	Code	Duke	Wife	Third Skull
Glabella-occipital length	GOL	186	192	173
Nasio-occipital length	NOL	182	190	171
Basion-nasion length	BNL	111	126 (est.)[b]	97 (est.)
Basion-bregma height	BBH	143	140	128 (est.)
Maximum cranial breadth	XCB	141	137	130
Maximum cranial frontal breadth	XFB	124	113	114
Bizygomatic breadth	ZYB	134	129 (ext.)	
Minimum cranial breadth	WCB	indeterminate (damaged)	indeterminate (damaged)	76
Biasterionic breadth	ASB	120	115	110
Basion-prosthion length	BPL	100	115	89 (est.)
Orbital height left	OBH	36	36.5	31
Orbital breadth left	OBB	41	37	37
Nasal breadth	NLB	37.5	25	19.5
Palate breadth (exterior)	MAB	68	63	59
Mastoid height	MDH	34 (right)	28.5 (right)	
Mastoid width	MDB	31 (right)	25 (right)	
Bifrontal breadth	FMB	101	89 (est.)	92
Foramen magnum length	FOL	35	d	33 (est.)
Nasion-bregma chord	FRC	110	106	104
Nasion-bregma subtense	FRS	24	26	22
Nasion subtense fraction	FRF	50	47	49
Bregma-lambda chord	PAC	101	115	117
Bregma-lambda subtense	PAS	20	21	26
Bregma subtense fraction	PAF	60	63	47
Lambda-opisthion chord	OCC	101	85 (est.)	90
Lambda-opisthion subtense	OCS	31	25 (est)	24
Lambda subtense fraction	OCF	49	37 (est.)	50
Age		65	45	?
Sex		M	F?	F

[a]Compare lists offered in Vlček 1997, 247ff. All measurements of bilateral features are from the left side unless otherwise noted.

[b]In cases of slightly damaged bones, length was estimated, ± 2 mm.

Table 4.3. Stature of individuals (in centimeters) from Praha Hrad, area of the Church of the Virgin Mary in Courtyard II

Individual	Female (n = 12)	Male (n = 5)
12194 (cf. 12215A)	—	—
Unnumbered Individual Y	158.4	—
Unnumbered Individual Z	155.1	—
12215A	154.8	—
12215B	—	174.4
13131	162.5	—
13140B [A?]	—	179.8
13194	164.2	—
13253: Royal Tomb Prince	—	178.4
13253: Royal Tomb Princess	159.1	—
13269	159.3	—
13270	159.1	—
13271	160.8	—
13273	—	170.6
13381A	—	170.4
13382A	166.3	—
13462	157	—
13463A	166.5	—
Ranges	154.8–166.5	170.4–179.8
Averages	160.3	174.7

Despite the massive size of the skull and long bones of both the prince and his wife, neither of these people are the tallest person found in the sample of graves from Courtyard II. Table 4.3 demonstrates that each is in the upper range for their sex categories, but not the tallest. But the figures for cranial dimensions (see Table 4.2, below) clearly reveal a powerfully built pair of individuals whose massive musculature alone makes them distinct among their contemporaries.

Conclusions

In sum, the excellent contextual archaeological data enables us to examine diverse sets of skeletal material that have been excavated after intervals of many years and reassemble the information to provide a sample of 49 adults, of whom stature can be calculated for 17 individuals. The excavated area in Courtyard II within the Prague Castle around the structure identified as the Church of the Virgin Mary was used as a burial area for some period prior to the construction of the building. The cemetery around this church is similar to those found throughout the southern region of Europe during this period. The early tenth-century dates of the earliest interments of elite individuals in the tiny church correspond with dates known from Italian examples (Becker 1996a, 1997).

The principal individuals within the burial chamber of the church structure were identified as Prince Spytihněv and his probable wife. They were far more robust than the other people recovered in these excavations, but they do not demonstrate significantly taller adult statures than the lower-status peoples from their time. From this limited sample, stature, as a reflection of nutritional change through time and status differences within a contemporary population, was weakly correlated with the evidence of social rank, and therefore with status, within this forming early state.

Similarities in stature between the prince and others in this sample might be explained if the burials in the general area of the small church was used by other elites before and after the construction of this structure. For example, at the Farfa Abbey in Italy, the area immediately surrounding the apse was reserved for higher-status burials. Alternately, the similarities in stature may suggest that there was a lack of rigid social inequality and a relatively uniform pattern of nutritional intake during this early period of state formation. There are several possible explanations for the absence of strong evidence from stature data for social distance, and future research on oral health and stable isotope variation could definitively test the specific relationships between social status and stature. The use here of the Trotter and Gleser formulae for the calculation of stature depend on corresponding limb proportions of the Czech samples and the limbs used to calculate "American White" statures (cf. Becker 1999). Specific computations of formulae for determining stature in early Bohemia and the application of other biological approaches to evaluating status differences may better reveal how early state formation is reflected in the biology of the participants.

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Notes

1. The Czech Archaeological Service arranged for this extraordinary feature of the early history of the Czech Republic to be preserved and made visible to the public. The vast numbers of visitors and tourists who enjoy the many wonders of Prague Castle may see the original foundations of the Church of the Virgin Mary, which now is several meters below the present ground surface. An impressive viewing window has been built into the north side of the passageway between Courtyards I and II of the Castle. This opens over the ancient church, which has been made visible through a significant feat of engineering that preserved the more recent constructions above the passage.

2. The Lumbe Garden cemetery, located only 400 meters NW by W of the Courtyard II area, does not have the extremely disturbed graves that are typical of Courtyard II. The area of the Lumbe Garden, which lies at the margin or just beyond the central region that is critical for understanding the Courtyard II burials, has neither the density of graves nor the considerable extent of construction that has created so many archaeological difficul-

ties for the recovery of intact skeletons within the Castle. As Boháčová (1994, 154) points out, the preservation and recovery of skeletal material was influenced by other factors that impede extensive comparisons between these two cemetery "populations." Becker (2000a, 228) notes that 148 people from 141 graves (and thus one person to a grave is the norm) were excavated from the Lumbe Garden area of the Prague Castle and dated to a period extending from the end of the ninth to the early eleventh centuries (Boháčová et al. 1988; Frolík et al. 1988; Smetánka et al. 1973, 1974; Smetánka 1994; also Frolík et al. 1992, 151).

3. An obvious anomaly in the age distribution of the people interred in this area of Prague Castle can be seen in Table 4.1 and warrants comment. The extremely low numbers, or near-absence, of perinatals and primiparas suggest to me that they are buried elsewhere (see Becker 2005b). The probability that separate cemeteries were used for these people or that perinatals were buried under the eaves of houses (*suggrundaria*; see Becker 1996b) or under the floors of houses (see Becker 1995b, 1997, 2006, 2007) can be addressed only through archaeological research and skeletal analyses from other locations in this area of medieval Prague.

4. Prof. Vlček inventoried the bones of the duke, his presumed wife, and a third skull (Unit 13253) in 1992. These skeletons are part of the Prague Castle Museum collections. Other skeletal collections from Prague and other parts of the Czech Republic are held in storage at the Anthropological Department of the National Museum in Prague. The principal depository of the vast collections available in Prague is the storage facility of the Anthropological Department of the Institute of Archaeology, located at Horni Počernice.

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II

Complexities of Sex and Gender

5

Skeletal Morphology and Social Structure in Ancient Egypt

Hierarchy, Gender, Body Shape, and Limb Proportion (4000–1900 BC)

SONIA ZAKRZEWSKI

As noted in the introduction to this volume, the effects of social hierarchy may be identified osteologically by various means, including differential health outcomes. The chapters in this section amply demonstrate that some potential consequences of social stratification may become biologically embodied in aspects of differential growth patterns, adult stature, and other socially sensitive morphometric characteristics of the human body.

This chapter develops a bioarchaeological model of understanding how gross skeletal morphology may reveal social structures in a state-level population. Using a series of temporally successive skeletal samples from Egypt, it explores aspects of the development of hierarchy through their impact on the skeletal biology of sex and gender differentiation. Given that bioarchaeological research project budgets are often limited, it also explores the study of social differentiation through traditional (and thus cost-effective) osteological methods.

The Biology of Human Growth and Development

Human growth is the outcome of a series of complex interactions between an individual's genes and their local environment. The most important components of the latter are childhood nutrition and infection. Various theoretical models have proposed relationships between the effects of environmental influences during childhood growth and development and functional biology that lead to morphological variation within populations (Zakrzewski 2003), building on the known interactive synergisms between

infection and malnutrition in order to predict an individual's terminal adult height. Each person is born with his or her own genetic potential for growth that represents the maximum possible height to which that individual can grow. This genetic potential varies, but there are concrete links between growth patterns, diet, disease, subsistence, and socioecology. A series of sustained long-term processes, such as interplays between biological stresses and plasticity, can be significant constraints or limitations that have an impact on an individual's physiology. Consequently, individuals with relatively poor diets suffer proportionally greater effects of infection. Following this approach, poorer or lower-ranking individuals are predicted to exhibit greater negative feedback loops in their growth processes that leads to greater impingement on childhood growth when compared to more highly ranked individuals.

Individual bones and limbs have differing growth curves. Proximal segments develop earlier in childhood than distal portions (Harrison 1992; Scheuer and Black 2000; Sinclair 1989). Skeletal maturity is thus relatively advanced distally in comparison with more proximal portions or segments of limbs. Childhood growth occurs in a series of spurts, and disturbances to the overall growth pattern and trajectory affect the portion of the body that is growing at that particular time period. Different portions of the body therefore have different sensitive periods to growth stressors. Tanner's growth model (1963, 1989; Bogin 1994, 1999) demonstrates the potential for catch-up growth, but long-term growth impairment occurs if there are prolonged interruptions or insults to childhood growth. Gain in sitting height is associated with both the infantile and pubertal components of human growth, while gain in leg length is more associated with the childhood phase (Bogin 1999; Harrison 1992; Karlberg 1998). Maximum growth is attained first by the tibia, then the femur, the fibula, and the bones of the upper extremity (Malina and Bouchard 1991). Adult stature can thus be seen as a reasonable reflection of childhood conditions, and aspects of variation in body shape, beyond its ecogeographic significance, may reflect patterns of childhood biological stress and their impact on the body of an individual.

Bielicki (1986, 1998) has argued that growth patterns can be an indicator of social inequalities both in terms of intergenerational secular trends and, as is relevant for this study, as social gradients. Furthermore, because of somatic growth patterns, Bielicki (1998) suggests that social class differences in height and growth are most accentuated during adolescence. Hence, those in higher social classes may mature biologically and skeletally

earlier in their lives, whereas lower-ranked individuals have slower growth patterns (Bielicki 1998). If stressors that disrupt growth are present, prolonged growth does not occur, thereby leading to a relatively stunted adult. Within a malnourished population, young children who exhibit a greater degree of stunting end up as the shortest adults (Golden 1996). Furthermore, genetic, epigenetic, and nongenetic factors exist in a feedback loop whereby stunted adults tend to have smaller children who grow up to become relatively small adults (Addo et al. 2013).

Hierarchy in Egypt

The prehistory and history of ancient Egypt can be characterized as a study in the development of hierarchical social differentiation associated with the emergence of state-level sociopolitical organization that features highly privileged elites. Although the processes linked to the formation of the Egyptian civilization originated in relatively egalitarian social groups, hierarchy and the Egyptian state developed relatively rapidly in a geographically and environmentally confined area.

Sedentary lifeways in the Nile Valley may have developed during the early Holocene as a result of the systematic exploitation of Nile channels for catfish and of the neighboring savannah for aurochs. This, together with the expectation that gazelle would return at the start of the warm season, the harvesting of wild cereals, and exploitation of lithic resources, may have led to incipient territoriality. The population became relatively sedentary; the first evidence of cultivated plants and granaries dates to ca. 5500 BC (Midant-Reynes 2000a).

The Badarian culture (ca. 5500–3800 BC) was first documented when the graves of "wealthy" individuals were found on the east bank of the Nile in Middle Egypt. The graves were oval pits that a single individual was buried in a flexed or contracted position, lying on the left side with the head to the south and facing west (Brunton 1937, 1948). Burials were usually carefully arranged; the body was placed inside a mat on the ground and then covered or wrapped in either a gazelle skin or a goat skin and associated with funerary pottery (Brunton 1937; Brunton and Caton-Thompson 1928). These ceramics, which were the most distinctive characteristic of the Badarian material culture (Midant-Reynes 2000a), were handmade from clay tempered with chaff and normally were decorated with simple motifs. Decorative ivory ware, including combs with stylized animal motifs were also found; these wares were associated with human forms fashioned in

clay and ivory (Midant-Reynes 2000a). Other figurines are of boats and animals such as hippopotami and gazelle. Siltstone palettes sometimes retained traces of ochre or malachite from pigment grinding. Badarian material culture also included objects made of turquoise, copper, steatite, and seashells, indicating contact with groups from areas such as Palestine (Arkell 1975; Hendrickx and Vermeersch 2000; Midant-Reynes 2000a). Animal skulls regularly appeared in graves alongside a human body; most crania were those of cattle, sheep, antelopes, cats, jackals, or dogs. Complete animal burials were interred using the same wrapping as those of humans (Holmes and Friedman 1994). Settlement remains consist of traces of circular pits that have been interpreted as silos for food storage and shallow layers of burnt organic deposits (Hassan 1988), probably involving several small villages or hamlets.

Following the Badarian cultural period, the Early Predynastic period (ca. 3800–3400 BC) involved changes in mortuary programs and material culture. The dead were buried on their left sides in a contracted position, with the head to the south, facing west. An increase in the number of bodies buried in small pits have been noted, and a few individuals began to be buried in larger and more elaborate graves during this time (Castillos 1982, 1998). Burials were associated with a greater range of artifacts than was the case in the Badarian period. Disc-shaped stone maceheads served as portable symbols of power and were placed in larger tombs, such as at Hierakonpolis. Diversity in siltstone palette shapes increased, and bone and ivory production flourished. During the Early Predynastic period, pottery vessels were occasionally decorated with white painted designs that included geometric and animal motifs. Riverine fauna were often represented, such as crocodiles and hippopotami, but depictions of people and boats also exist. This period included the first occurrence of pot marks that were incised after firing, potentially indicating concepts of ownership. Stone projectile points were rare, unlike in the preceding Badarian era, implying a clear reduction in the importance of hunting to subsistence. Many of the bifacial stone tools, such as sickles, suggest that plant foods played an important dietary role. Barley, wheat, peas, and vetch were cultivated, as was a possible ancestor of the watermelon. Faunal analyses have identified domesticates such as goats, sheep, bovids, and pigs (Hassan 1988). Settlements were mainly in the form of round huts that were partially dug out of a surface of beaten earth. Some huts appear small and may have functioned as storage areas, whereas larger ones included hearths and may represent living areas. At Hierakonpolis, however, evidence of larger rectangular substructures

with walls plastered with mud and dung have been found (Adams 1995). Such diversity in occupational sites suggests some degree of economic and social variation.

The Late Predynastic period, ca. 3400–3100 BC, marked the development of the first genuine urban centers at Hierakonpolis, Naqada, and Abydos. Burials were normally simple pits with single bodies, although multiple burials became more common. During this period, the trend of fewer and fewer individuals being buried in richer tombs with more abundant grave goods accelerated (Castillos 1982, 1998). Certain funerary offerings began to be placed separate from the body in compartments, leading to increasing structural complexity of the tombs. Furthermore, funerary forms diversified to include small round pits without funerary goods, burials inside pottery vessels, oval or rectangular pits with grave goods in varying frequencies, and different types of wrappings and coffins (Midant-Reynes 2000b). This variation strongly indicates the growing social complexity of the period and an associated increase in the hierarchical nature of society. Motifs on ceramic goods included nonfigurative shapes (spirals, waves, and checked patterns); scenes depicting boats and fauna of the Nile environment, such as flamingos; and scenes depicting the desert environment that included gazelle and antelope (Midant-Reynes 2000b). The disc-shaped macehead of the Early Predynastic period was replaced by a pear-shaped form; this symbol of power persisted into the Pharaonic period. The copper industry began to flourish as copper metallurgy intensified, and this process that paralleled the production of gold and silver. Although the earliest artistic representations of metal workers appear only in Old Kingdom burial mastabas, similar specialists must have undertaken this earlier work, which would have involved differential mobilization of labor and the creation of a class of nonproducers. The first recognizable specialized workshops emerged during the Late Predynastic, when large-scale pottery was produced by specialized potters, implying the presence of hierarchical social organization. As noted earlier, this period marks the start of genuine urbanization. Butzer (1976) estimated that during the Late Predynastic period, approximately 16,000 km^2 were under cultivation that supported 300,000 inhabitants.

By ca. 3200 BC, the population of Upper Egypt existed as a series of scattered villages associated with three urban centers: Naqada was at the end of the gold-mining route through the Eastern Desert, Abydos controlled trade to the north, and Hierakonpolis, at the southern border, was a center of trade in gold, copper, and ivory with the south. Within these urban centers,

enormous brick-built tombs provide evidence of a powerful elite. Funerary and religious art depicted motifs later associated with kings (e.g., depictions of hunting, warfare, and ceremonial activities and images of the leader as a bull, a hawk, or a lion slaughtering rebels) (Manley 1996). The towns developed into city-states under the influence of "kinglets" who maintained an increasingly strong control over trade and migration (Midant-Reynes 2000a, 2000b).

A transition thus occurred after the Early Predynastic period from a relatively egalitarian society to one that was materially more prosperous and was stratified along class-based lines, as inferred from the dramatic increase in the number of objects per burial (Castillos 1983). Beginning with a random distribution of rich graves in the Badarian and Early Predynastic, there was a progressive tendency for richer graves from the Late Predynastic onward to cluster together in cemeteries. Castillos (1983) argues this implied a generalized desire of more privileged members of society to be buried close to one another, thereby perpetuating the socioeconomic ties linking them together and differentiating them from the rest of the population. Archaeological evidence of early Egyptian society, therefore, suggests social division formed along a primary axis that involved vertically differentiated rank, rather than sex or gender.

The Early Dynastic period lasted from ca. 3050 BC until 2686 BC (Adams and Ciałowicz 1997) and featured distinct social classes: the nobility, officials and artisans, and the peasantry (Ikram 2010, 165–168). Each group was distinguished by separate mastaba burial grounds with differing qualities of funerary architecture and artifacts. Some of the mastaba tombs also had large architectural elements made of stone and roofing timbers that were so large that they likely originated from the coastal forests of western Asia (James 1979). The early Dynastic kings were buried with their courtiers at Abydos. This period was characterized by the manufacture of stone vessels and a simultaneous decline in pottery production. Although flint tools were still used (Emery 1961), metallurgy flourished. Definitive evidence of trading contact with regions outside Egypt, such as Syro-Palestine, exists through the documentation of oil and perfume containers (Kantor 1965).

At the peak of Dynastic social organization was the pharaoh and his family. Directly below him in the capital city were court officials, overseers, and market farmers. In the provinces (*nomes*), the social elite consisted of the nomarch (the high commissioner of the province), followed by the estate managers and priests. Below them were skilled craftsmen and scribes.

At the bottom of this vertical social ranking system were farm laborers, herders, fishermen and others involved in manual occupations.

The Old Kingdom (ca. 2686 to 2181 BC), which directly followed state consolidation, was the first period of great prosperity (Phillipson 1993). During the Old Kingdom, the great pyramids, such as those built at Giza by Khufu, Khafre, and Menkaure, were constructed. The size of funerary architecture increased, and mortuary temples occupied the center of an enormous complex of other buildings. By the middle of the Old Kingdom, traditional items of high status, such as ceremonial knives, mace heads, and palettes were no longer produced, since the right to work material such as ivory could be granted only as an exceptional royal privilege (Manley 1996). The artistic high point consisted of the series of reliefs decorating the walls of royal temples, which include representations of hunting, fishing, fowling, sowing, reaping, bee keeping, and stock breeding. Butzer (1976) estimated that the population had risen to 1.5 million, although the area of land under cultivation had not proportionally increased. Towns became larger and more internally differentiated, but cities really developed only from the Middle Kingdom onward (Brewer and Teeter 1999).

Over time, this highly centralized state began to slowly fragment as provincial governorships became loosely hereditary roles, thereby turning provincial governors into feudal potentates. This resulted in loss of status associated with each social class and the decentralization of authority. The Old Kingdom was followed by the breakup of the Egyptian state during the First Intermediate Period, which is characterized by power struggles between changing confederacies of towns such as Edfu and Thebes (James 1979). Eventually Thebes established dominance and a Theban ruler assumed the title of King of Upper and Lower Egypt and founded the reunified Middle Kingdom.

During the Middle Kingdom (ca. 2040 to 1785 BC), the capital was moved and construction of large-scale funerary monuments restarted (Manley 1996). Military campaigns were fought against the Bedouin and Libyans in the north, Samarians to the northeast, and Nubians in the south (James 1979). Egypt again became a highly centrally organized polity with a vigorous foreign policy and an active foreign trade. Lower Nubia was annexed and a series of fortresses were constructed there for protection. The Dynastic periods are noted for complex but clearly delineated social roles and a form of social organization in which clearly defined boundaries vertically separating the pharaoh, nomarchs and priests, skilled workers and scribes, and laborers and slaves. Trade with and conquest of neighboring

areas also took place. Although reliance on agriculture was absolute, complex irrigation methods were not practiced until the Middle Kingdom.

Egyptian Subsistence and Social Roles

The temporal changes in the structure of Egyptian social organization and subsistence patterns have implications for gender roles. The Badarian culture was the earliest Egyptian society of reasonable population size and its members had a relatively egalitarian and mobile existence. Their subsistence strategy focused on pastoralism plus some agriculture based on the annual flood cycle and a heavy reliance on hunting. During the Early and Late Predynastic periods, reliance on agriculture increased. By the Early Dynastic period, the economy was entirely reliant on agriculture and life was structured around the timing of the annual Nile floods. Agricultural practices became more complex during the Middle Kingdom of irrigation systems were introduced and Nile flood levels became higher (Bell 1975).

During the Predynastic periods, gender appears not to have had any structuring effect on mortuary treatment and ritual (Savage 1999). Predynastic cemeteries tended to have balanced representation of the sexes and were relatively egalitarian in terms of grave good distribution, although at Naqada, males tended to be placed in larger graves (Castillos 1982). Funerary contexts at Naga-ed-Dêr suggest that women filled all the social roles available to men and other roles not filled by males (Savage 1999). However, the distinction between male and female occupations was "already entrenched in Egyptian society by the Old Kingdom and continued throughout pharaonic Egypt" (Robins 1993, 111). By the Early Dynastic period, male tombs tended to hold richer grave goods (Castillos 1982). During Dynastic periods, although women were always entitled to their own grave (Strouhal 1992), most were buried with or near their husband and the elaborateness of the burial was determined by the husband's social standing (Watterson 1991). According to Old Kingdom statues, wives are either portrayed kneeling at their husbands' feet and on a smaller scale than their husbands or are seated to the husband's left (which was considered to be inferior to his right side). Very few sculptures exist of women alone: most show women in conjunction with their spouse (Watterson 1991). Accordingly, Savage (1999) suggests that patriarchy, as practiced in Egypt, might have had its origins in the Late Predynastic and Early Dynastic periods.

During the Pharaonic period, women were accorded the same legal rights as men of the equivalent social class and land was inherited via a

matrilineal system. However, a woman's main occupation was running the household and bearing children (Watterson 1991). Women's responsibilities included grinding cereal, baking bread, and brewing beer (Strouhal 1992). Despite the facts that women's legal standing was equivalent to that of men and female deities such as Isis were culturally important, cemeteries and iconographic representations imply that from the Late Predynastic and Early Dynastic onward, women were not considered to be socially equal to men. Thus, although Egyptian state formation appears to have been an internal process, it deeply impacted gender roles and status and "the changes in women's status were the result of the process of centralizing state power" (Savage 1999, 91).

Research Hypotheses

Given this background, I hypothesized that the development of hierarchy in Egypt affected human bodily growth. First, I predicted that stature changed as a result of the intensification of agriculture. If agricultural intensification led to food supplies becoming more reliable, we would expect stature to increase. If, however, prolonged episodes of stress related to food supplies occurred, such as those resulting from harvest failure, one would expect stature to decrease. Second, I predicted that sexual dimorphism in stature increased as a result of the fact that divergent gender roles had a greater impact during the Dynastic period than it did in the preceding periods. Third, I hypothesized that greater diversity in male body shape existed in the Dynastic than in the Predynastic periods as a result of the fact that rank was based on "male" activities. Finally, I predicted that aspects of social changes seen in iconography and art would be manifested and reflected in morphology and human biology.

Materials and Methods

A series of six temporally successive skeletal samples were studied, dating from the Badarian (ca. 4000 BC) to the Middle Kingdom (ca. 1900 BC). Skeletons were studied only if they could be reliably dated to one of these six periods. Bones from 150 individuals were measured (for further details regarding these the samples, see Zakrzewski 2003). Skeletal sampling was restricted to sites from Middle and Upper Egypt; thus, all individuals likely lived in reasonably similar geographic and climatic conditions.

Material from several cemetery sites was aggregated for most periods.

For the earliest period (Badarian), all human remains originated from El-Badari. The Early Predynastic material derives from Abydos cemetery (13 males and 13 females) and Gebelein (15 males and 19 females). The Later Predynastic sample derives entirely from El-Amrah, where the graves were furnished with ivory, lapis lazuli, copper, silver and gold (Wilkinson 2001). The Early Dynastic material mainly originated from Abydos (13 males and 11 females, of which three males and four females derive from the Tombs of the Courtiers cemetery), while El-Amrah provided one male and one female. The people buried in the Tombs of the Courtiers may have been funerary priests (Hoffman 1979), minor palace functionaries, members of the royal harem, or artisans (Trigger 1983). These retainers, who were buried in subsidiary graves surrounding the pharaohs' tombs, have long been considered to represent individuals who were ritually killed so they could continue to serve the king after death (Trigger 1983). The remainder of the Abydos Early Dynastic material derives from Cemetery C and may represent a socioeconomically poorer section of Abydos society (Duhig 2000). The Old Kingdom sample derives from Medum (three males and four females) and Giza (thirteen males and five females). The Medum remains come from the lesser pit burials around the Medum pyramid (Petrie 1892), and the Giza sample originated from the western necropolis attached to Khufu's pyramid (Leek 1986) and consists of the skeletal material of Khufu's retainers (Aldred 1998). The Middle Kingdom material originates from Gebelein, where a colony of Nubian mercenaries who married Egyptian women is known to have settled (Fischer 1961).

Analysis was limited to adults. Skeletal maturity was determined on the basis of the fusion of the sphenooccipital synchondrosis, epiphyseal fusion, and complete eruption of third molars. Sex estimation was based on the standards of Buikstra and Ubelaker (1994) using sexual dimorphism of the os coxae and skull (for further details, see Zakrzewski 2003). Each long bone was measured individually following Martin and Saller (1957) and Bräuer (1988). The total sample consisted of 997 long bones. Where paired long bones were present, mean values wer e calculated.

Stature estimates were computed following Raxter et al. (2008). This method derived from a series of stature prediction equations designed specifically for use with ancient Egyptian populations. Whenever possible, the following equations were used:

$$\text{Male stature} = 1.282\ (\text{femur}_{max} + \text{tibia}_{max}) + 59.35$$

$$\text{Female stature} = 2.700\ (\text{tibia}_{lat}) = 59.35$$

These equations use maximum femoral length and maximum tibial length for males and tibial length measured to the lateral condyle for females (measured in cm). These equations were selected for each sex as they have the smallest standard errors of estimate (SEE) and the highest *r* values of all predictor equations. When these bones were not sufficiently well preserved for these lengths to be measured, other prediction equations were used, with preference given to equations with smaller SEE. These tend to use maximum femoral length, bicondylar femoral length, maximum tibial length, and tibial length measured to the lateral condyle. Computed statures were compared with previously published Egyptian stature data (Grilleto 1979; Masali et al. 1966; Robins 1983; Robins and Shute 1983, 1984; Smith 1912; Volante 1974; Zakrzewski 2003).

Results

Computed adult statures for both the series of Egyptian skeletons that were measured and comparative samples are shown in Figure 5.1. Although all comparative statures were computed from long-bone lengths, the precise methods used to estimate height vary between studies; some used Manouvrier tables and others followed the methods of Pearson (1899), Telkkä (1950), Dupertuis and Hadden (1951), Trotter and Gleser (1952, 1958), or

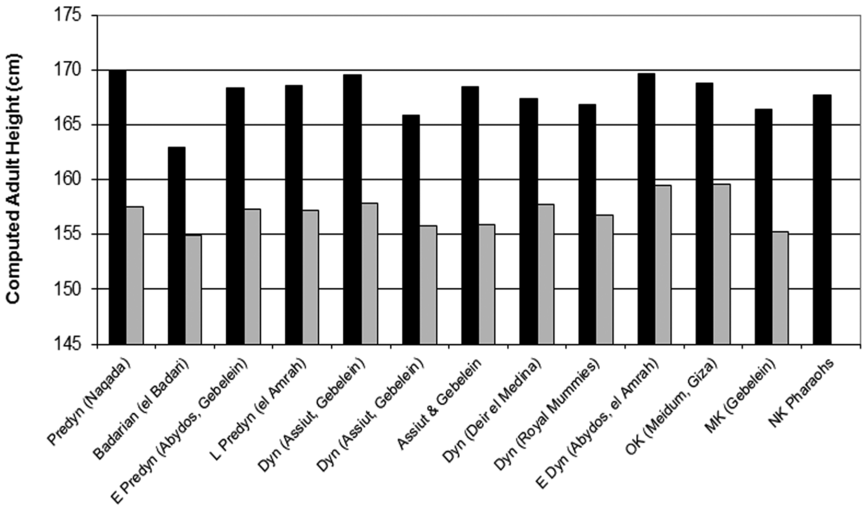

Figure 5.1. Computed adult heights for an Egyptian skeletal series (in chronological order) based on data published in Grilleto (1979), Masali et al. (1966), Robins (1983), Robins and Shute (1983, 1984), Smith (1912), Volante (1974), and Zakrzewski (2003). Male stature is represented by dark gray bars; female stature is represented by light gray bars.

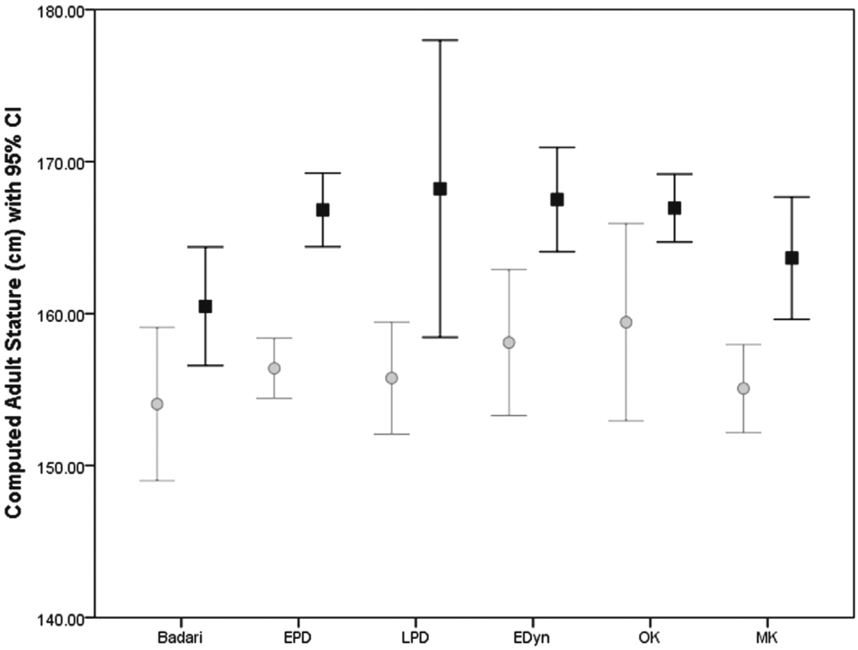

Figure 5.2. Computed adult heights with 95 percent confidence intervals. Data were obtained from skeletons from El-Badari (Badarian period), Abysos and Gebelein (Early Predynastic), El-Amrah (Later Predynastic), Abydos and El-Amrah (early Dynastic), Medum and Giza (Old Kingdom), and Gebelein (Middle Kingdom).

Robins and Shute (1984) and one study did not provide any explanation of method used. This makes statistical comparison difficult. Furthermore, the sample sizes vary from more than 100 individuals (Predynastic Naqada) to only two in the female Dynastic sample from Deir-el-Medina. Still, adult mean statures demonstrate remarkably little variation across both time periods and samples.

Figure 5.2 shows the average estimated stature for each time period by sex for the 150 measured individuals and the 95 percent confidence intervals associated with each of the sample mean stature predictions. Male stature increased from the Badarian period through to the Late Predynastic period and then declined toward the Middle Kingdom. The pattern in female stature is not as clear, but there was an increase from the Badarian period into the Old Kingdom followed by a decrease into Middle Kingdom times.

The relative height of females compared to that of males is a measure of the degree of sexual dimorphism in computed adult stature within a

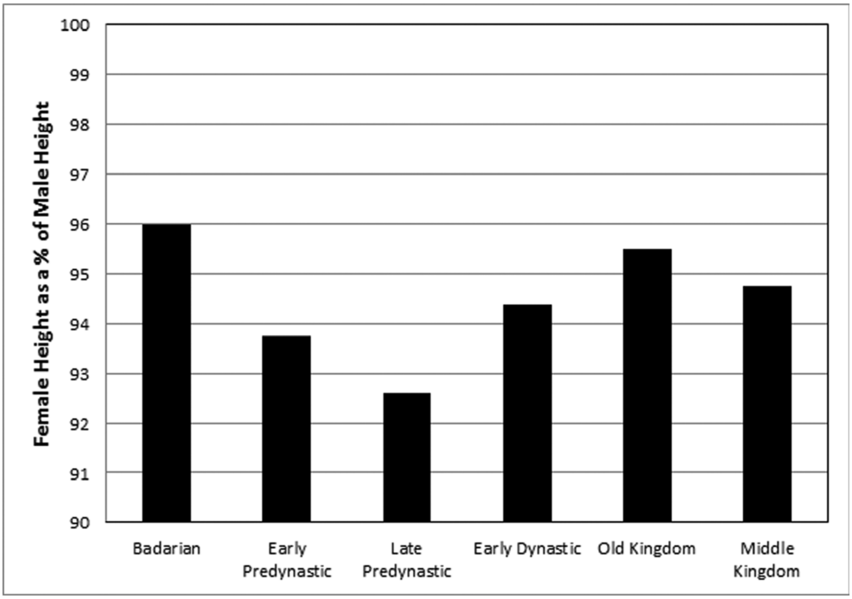

Figure 5.3. Computed female adult mean stature as a percentage of computed male adult mean stature by time period. Data were obtained from skeletons from El-Badari (Badarian period), Abysos and Gebelein (Early Predynastic), El-Amrah (Later Predynastic), Abydos and El-Amrah (early Dynastic), Medum and Giza (Old Kingdom), and Gebelein (Middle Kingdom).

specific sample (Fig. 5.3). On average, males were 5.5 percent taller than females. Greater sexual dimorphism was stature is seen in the Predynastic groups than in the later Dynastic groups (Fig. 5.3). The time period samples were subdivided on the basis of the social ranking of the cemetery from which they derived, and the relative heights of the females with respect to the males were replotted in Figure 5.4.

Discussion

The development of hierarchy and complex social organization in ancient Egypt occurred relatively rapidly and in association with intensification of the transition to a complete reliance on agriculture. Given that these processes occurred primarily as indigenous developments (Irish 2005, 2006; Schillaci et al. 2009; Zakrzewski 2007a), biological changes in the morphology of the Egyptian population at the time should reflect aspects of these socioeconomic changes. As noted earlier, body shape can reflect distur-

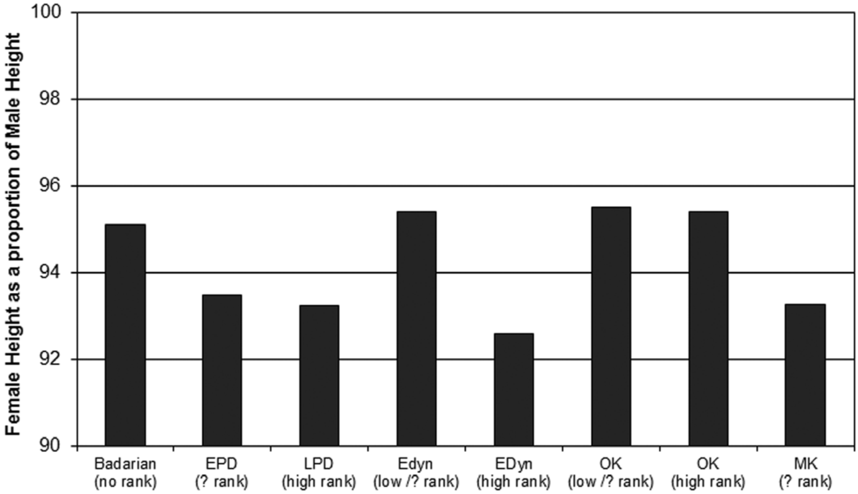

Figure 5.4. Computed female adult mean stature as a percentage of computed male adult mean stature by time period within potential social classes. The Early Predynastic material from Abydos includes samples from two cemeteries. Individuals from the Tombs of the Courtiers are likely individuals of higher social rank than those from Cemetery χ. The Old Kingdom sample includes two cemeteries. Individuals from the Giza western cemetery are considered to be of higher rank than those from Medum.

bances to growth in childhood, but intralimb indices are less developmentally canalized (or are more tightly limited and controlled) than body shape and hence can change within relatively short periods of time in response to socioenvironmental factors (Auerbach 2012; Temple and Matsumura 2011). Indeed, unusual and potentially unique aspects of the ancient Egyptian body plan and intralimb proportions have been described (Bleuze et al. 2014).

Ancient Egyptian Stature

As summarized earlier, an individual's adult stature and their body shape is the product of the processes of somatic growth. Each person's bodily growth can be affected by a series of socioeconomic factors (Bogin 1994, 1999; Eveleth and Tanner 1976, 1990; Komlos 1995; Steckel 2008; Steckel and Rose 2002). These include a culture's subsistence strategy and its impact on nutrition, the effects of occupation on the body through repetitive activities and trauma, the local environment, climate and vegetation, and overall disease prevalence and virulence. As agriculture is adopted and sedentism increases, a decline is commonly noted in the quality of nutrition

that is associated with a reduction in body size and robusticity of the adult population (Cohen and Armelagos 1984; Cohen 1989; Larsen 2015).

In Egypt, the formation of social complexity and the development of state hierarchy occurred simultaneously with agricultural intensification. A change in growth, adult height, and body shape, would therefore be expected to occur as a result of the transition from the relatively egalitarian Badarian population, which practiced a simple agricultural-pastoral subsistence strategy, to the highly socially stratified Egyptian population living in the New Kingdom period, which practiced intense cultivation. In simple terms, I predicted that this increase in social complexity was associated with increased variance in long-bone lengths and stature and an increase in postcranial sexual dimorphism.

Adult stature has been estimated for many Egyptian skeletons (Figs. 13.1, 13.2), and significant differences in mean heights have been noted between the sexes and between some time periods (Zakrzewski 2003). Despite these differences, the overall pattern of similarity in Egyptian adult stature is unusual and unexpected given the approximately 3,000-year time span between the earliest samples and the New Kingdom pharaohs. A reduction in male stature was found during the Dynastic periods; the greatest decrease occurred between the Old Kingdom and the Middle Kingdom. The period under study includes significant changes in subsistence practices and the development of an intense state-level hierarchy that resulted in extreme differences in social ranking between groups (Fig. 5.1). Despite the varying sample sizes and methods of stature computation, either the New Kingdom pharaohs are unexpectedly short relative to the Predynastic males from Naqada or the Early Dynasty males from Abydos and el-Amrah are unusually tall.

The 95 percent confidence intervals in height predictions (Fig. 5.2) demonstrate the variability of adult heights within each time period sample. This evidence shows that Egyptian adult stature remained remarkably stable. During the Late Predynastic sample, there is more variation in the computed statures of males than there is for females. This suggests greater diversity in the male Late Predynastic population than in the contemporaneous female population. As described earlier, the Late Predynastic is the period when there was acceleration in the development of social hierarchy. Within these skeletal samples, the effects of greater social differentiation appear to have had a greater biological effect among men. In contrast, during the Old Kingdom, females exhibited greater variability in height, implying greater impacts of social differentiation among women than among men

from this time period. This is noteworthy because by this period, Egyptian women are depicted only in relation to their husbands. Furthermore, by the Old Kingdom, trade and exchange between Egypt and neighboring regions was flourishing, and it is likely that there would have been some degree of immigration of peoples to the Nile Valley from these neighboring areas.

Early childhood growth in Egypt appears to have been be highly canalized. Human growth is inherently plastic; it responds to environmental and sociocultural stressors. Growth stunting is only one manifestation of a general syndrome of developmental impairment, and the timing of the growth perturbation is vital in terms of its long-term impact (Floyd and Littleton 2006). Growth impairment through the very first few years of life largely determines a small adult stature, and a delay in the onset of the childhood phase of growth is the key determinant of growth faltering (Karlberg et al. 1994). Growth stresses that occur the first two years of life are the most likely to shape adult stature (Boldsen 1998; Floyd and Littleton 2006). Because of growth plasticity, stresses after this age rarely produce long-term effects on stature (Bogin 1999; Temple 2008). The results presented here could suggest that the timing of episodes of growth disruption in Egypt likely were experienced by older children and that, in the end, individuals could recover from early stresses.

Egyptian Body Shape and Proportion

Body shape can be assessed by analysis of long-bone lengths in a variety of ways. Methods include comparing measurements of tibial length for individuals from different time periods, comparing the ratio of one long bone to another (using, for example, crural or brachial indices), or by considering the relative inputs of different portions of the body to adult height. Both raw measurements of long-bone lengths and some of these ratios of long-bone lengths indicate significant change between Egyptian time periods. For example, for both sexes, the pattern of changes in femoral length over time mirror the curve or bow-shape trend line exhibited earlier by height (i.e., a gradual increase followed by a decrease), whereas no clear trend can be seen in the changes in tibia length through time. This implies that most of the increase in stature noted through the later Predynastic and Early Dynastic is due to an increase in the length of the femur rather than an increase in the length of the tibia, thereby producing a slight change in ancient Egyptian body plan. Furthermore, greater change is observed in the lengths of male femurs. The male femur increased in length by 6.5 percent from the Badarian minimum value to the Early Dynastic maximum.

Female femur length did not change at the same rate; the increase for the same period for females was only 4.1 percent.

The relative proportion of adult body height comprised of leg length (maximum femur and physiological or complete tibia length) varied between time periods. Relative leg length (i.e., as a proportion of body height) was at its lowest during the Badarian period and gradually increased over time to reach its greatest during the Old Kingdom; this was followed by a decline in the Middle Kingdom. Associated with this was a change in the relative proportions of the arm. The length of the humerus decreased relative to the length of the ulna through time. The brachial index exhibited similar, although less clear, temporal change. Interestingly, in contrast to the sexual dimorphism in the variability of adult height, no increase in the variability of the raw bone measurements was found through time.

Although the term "race" is discredited on the grounds that there is no genetic basis to match the folk concept (Templeton 1998), compared with other human groups, ancient Egyptians have been described as having a "super-Negroid" body plan (Robins 1983). By this, Robins was trying to communicate that the Egyptians had a Nilotic body plan with proportionally relatively long limbs and elongated distal segments of those limbs. Indeed, Egyptian brachial and crural indices indicate that the distal segments of each limb were longer relative to the proximal segments than they were for many other African groups (Zakrzewski 2003). However, variation in Egyptian intralimb proportions has been noted, and the relatively "high intralimb indices and greater body mass relative to stature in the Kellis 2 sample [a Roman period sample from Dakhleh Oasis in Egypt's western desert] suggest that generalized terms to categorize Egyptians, such as 'tropical,' 'Negroid,' and 'super-Negroid,' may be grossly inaccurate and [may] additionally obscure localized adaptations within larger geographical areas" (Bleuze et al. 2014, 503, quoting Robins [1983] and Robins and Shute [1986]).

The temporal changes in body shape this series of Egyptian samples exhibited may reflect changes in body plan as a result of the development of social hierarchy or may reflect changes in ecogeography (Bleuze et al. 2014). It is hard to disentangle these aspects in the current study. Although relative statures could be computed for different cemeteries in each time period (Fig. 5.4), studies did not all use exactly the same configuration of long bones to compute adult statures. Sample sizes for some cemeteries or for one sex are insufficient to undertake statistically meaningful intercemetery analysis of crural or brachial indices. In addition, Raxter (2011), who

included these data as part of her sample, found significant differences in intralimb indices between Upper Egyptians, Lower Egyptians, Upper Nubians, and Lower Nubians in sex-specific comparisons. Although Raxter grappled with similar sample size issues and was also unable to compare intralimb indices between contemporaneous cemeteries, this might be undertaken in the future.

Sexual Dimorphism, Gender, and Inequality

The degree of sexual dimorphism and aspects of phenotype, such as stature, differ between human populations (e.g., Eveleth and Tanner 1976; Frayer 1980; Gaulin and Boster 1985; Gray and Wolfe 1980; Gustafsson and Lindenfors 2004, 2009; Hall 1982; Hauspie et al. 1985; Holden and Mace 1999; Ruff 1987, 2000; Stini 1975; Wolfe and Gray 1982a, 1982b). Sexual dimorphism in adult height varies between human groups: the male mean is usually 4.5 to 9.5 percent greater than the female mean (Gaulin and Boster 1985; Stini 1975). As noted earlier, Egyptian males are shown to be on average 5.5 percent taller than females and greater sexual dimorphism in stature is seen in the Predynastic groups than in the later Dynastic groups (Fig. 5.3). The relatively egalitarian Badarian period had the least sexual dimorphism in height, and the greatest stature difference between the sexes is found in the later Predynastic sample. During the later Predynastic, males were on average more than 12 cm taller than the females (meaning that females were less than 93 percent of the average height of the males).

Cross-culturally, the modern mean adult female height is usually approximately 93.5 percent of the mean adult male height (Gustafsson and Lindenfors 2004). It thus follows that the ancient Egyptians exhibit relatively minimal overall sexual dimorphism in height. Only the Predynastic sample had greater sexual dimorphism than the modern cross-cultural pattern. Here, maximum sexual dimorphism in stature was found in the Late Predynastic period (Fig. 5.3). Although this might initially seem surprising, it is perhaps not unexpected that the greatest degree of sexual dimorphism in adult height occurred during the Late Predynastic, as this is period when the most marked and rapid developments of social ranking and hierarchy occurred. In contrast, samples from the Dynastic periods exhibited surprisingly low levels of sexual dimorphism in height.

Low levels of stature sexual dimorphism were found in both the Early Dynastic and Old Kingdom samples. These may be artifacts of sampling or may be related to the social composition of the samples. This will be

explored further below. The unification of Upper and Lower Egypt at the start of the Early Dynastic is only part of the process of state development; Egyptian state formation also included the development of male-oriented cosmology and the imposition of a centralized religious organization and artistic style (Savage 1999). Savage has further argued that early pharaohs may have reworked the Predynastic cosmology into a male-centered system, thereby reducing the social roles and socioeconomic capital available to women. In this sense, the recognition of aspects of gender as seen grave size and grave goods, which indicate that males were preferred to females, does not seem to match with a biological response. It is possible that, instead, the biological corollaries involving sexual dimorphism occurred earlier during the Predynastic era and were more critically linked to the point when social changes in gender roles started to be delineated.

The Middle Kingdom sample derives from Gebelein, when Egypt's control spread south into Nubia and the Pharaonic frontier lay on the Second Cataract (in present-day Sudan). Evidence from funerary stelae suggests that from the period immediately preceding the Middle Kingdom onward, Gebelein had an associated colony of Nubian mercenaries (e.g., Stela Turin 1290, which Fischer 1961 described as Turin 1270). This stela describes a Nubian soldier and his wife and depicts him with his four brothers, who are also soldiers (Vandier 1943). Stela Berlin 24032 contains a brief biography that ends with a mention of Nubian mercenaries in the stela owner's hometown of Gebelein (Fischer 1961). At least five other stelae from the Gebelein area portray Nubians, who can usually be recognized by their distinctive bushy hair, darker skin tone, and typified Nubian clothing. Several of the stelae, such as Boston MFA 03.1848 (which specifically calls the individual depicted "Nehesy," the ancient Egyptian name for Nubians [Kendall 1997]) and Leiden F 1938/1.6 suggest that the Nubian mercenaries had married Egyptian women (Fischer 1961). It is therefore possible that at least some portion of the Middle Kingdom sample studied here includes either Nubian males or their descendants; this would likely have had an impact on both the greater variation in computed stature for males than females (Fig. 5.2) and the observed sexual dimorphism in stature (Fig. 5.3).

Social Groups, Class, and the Formation of Hierarchy

Given the samples included in the current study, it is difficult to assess the effects of social class on stature or body shape in Egypt. The samples consist of mostly aggregated cemetery groups and likely cut across social divisions.

Little is known of differences in social class during the earliest portion of the Predynastic era, but one might presume that the effects of social class would become apparent with the rise of social hierarchy during the Late Predynastic. The Late Predynastic sample in this work derives from El-Amrah, where funerary contexts were furnished with prestige materials that included ivory, lapis lazuli, copper, silver, and gold (Wilkinson 2001). This is suggestive of a relatively high ranking or social class of the local population and access to goods obtained through long-distance trade. The Early Dynastic sample consists of mostly skeletal material from Abydos, including the Royal Tombs cemetery. The graves in this cemetery were constructed for members of the palace entourage and may not be representative of the population of the town of Abydos at this period.

The Old Kingdom sample studied consists of skeletons from Medum and Giza. The skeletons from Medum come from the pit burials of low-ranking individuals around the pyramid (Petrie 1892), although it is thought that some of the Pharaoh Snofru's relatives are buried in the mastaba field (Wilkinson 2001). As a result, the social class of the Medum Old Kingdom individuals is uncertain. The Giza material derives from the western necropolis attached to Khufu's pyramid (Leek 1986) and likely consists of the remains of his attendants (Aldred 1998). As such, this group probably represents a relatively high social class. The Middle Kingdom material all originates from Gebelein, which, as discussed earlier, may include Nubian mercenaries or their descendants.

To summarize this data, little is known of social organization in the Badarian and Early Predynastic assemblages, although the Badarian were likely to be relatively egalitarian and likely lacked a vertical class-based structure. The Late Predynastic sample derives from a potentially high-ranking group. The Early Dynastic sample consists of at least some high-ranking individuals associated with the Royal Tombs from Abydos. The Old Kingdom sample includes high-ranking individuals buried in the Giza necropolis. These Dynastic groups derive from cemeteries in proximity to royal cemeteries, such as the pyramids at Giza and Medum, and hence may represent privileged groups. Finally, the Middle Kingdom sample may include Nubian mercenaries or their families.

The computed stature of adults exhibits remarkable stability across time in Egypt. This may result from differences in the social rankings of the various temporal samples. In other words, it is possible that the earlier Dynastic groups represent more highly ranked individuals than the (smaller) Middle Kingdom sample (Fig. 5.3). When separated by cemetery hierarchy, sexual

dimorphism in the Middle Kingdom is similar to that of the high-ranked Early Dynastic sample. Analysis of sexual dimorphism indicated greater differentiation between males and females of potentially high social class than between those of potentially lower or unknown social class during the Early Dynastic (Fig. 5.4). During this period, the stature of higher-ranking females is less than 93 percent of the height of the potentially high-ranking males. In contrast, the lower-ranked sample exhibits less sexual dimorphism: lower-ranking females were more similar in stature to their peer-group males.

Interestingly, no statistically significant differences were found in computed adult stature, femur length, or tibia length between what archaeologically appear as different social classes in the cemeteries of each time period. This may be a function of relatively small sample size. Social class in association with social hierarchy may have played some role in stature and body shape development in Egypt, and larger skeletal sample sizes may be required to better evaluate this possibility. It is possible, however, that after the initial development of social complexity and rank, differential access to food, health care, or other resources may have been determined by membership of social groups and respective position in the social hierarchy and thus may have acted to reduce the effects of sexual dimorphism on ancient Egyptians.

The skeletons included here derive from a series of sites, many of which were used and reused through time. The Abydos region was at the heart of the state formation process (Wilkinson 2001). Lying at the crossroads of trade with the western oases and the upper Nile Valley (Bard 1994), the town was located in the richest region for resources and may have had a greater capacity to produce and control surplus foods and other resources. These factors and the Abydos cemetery sample's links with the early pharaohs may mean that the sample is not truly representative of the periods from which they originate. These individuals may have been socially higher ranked than people from other areas and may have had better access to food or other resources. Giza also was in an area with greater control of trade because of its location as the linking point between the Nile Valley and the Delta. The Giza Old Kingdom material may thus have had greater social differentiation than that from Medum. The data in this study is a starting point, but without the ability to match specific skeletons with their tombs, we cannot currently elucidate the details of this internal social differentiation.

Egyptian Art and Hierarchy

It is also instructive to consider that in all forms of Egyptian art, the representation of the human figure was governed by a series of rules developed during the Predynastic era (Weeks 1970). A fundamental convention was that each part of the body was shown in what was considered to be its most characteristic or identifiable form and the various body parts were put together to form a composite image (Robins 1994). However, the specific body parts were represented with remarkable anatomical detail and remained relatively unchanged throughout the Predynastic and Dynastic periods, which suggests that the Egyptians believed that there was only one idealized form of human body (Weeks 1970).

Everyone who produced Egyptian artwork used a standardized framework (called the "Egyptian Canon") to make representations of the human figure conform to relatively natural proportions of the Egyptian body (Iversen 1975). Although variable through the Predynastic and Early Dynastic, the framework was reasonably fixed by the middle of the Old Kingdom, although some lengthening of the leg is found in human representations by the Middle Kingdom (Robins 1994). Over the same period, a decline in the detail of anatomical features has been noted (Weeks 1970). This has been argued to have the effect of "feminizing" male representations, and so a kind of gender dimorphism became expressed through the exaggeration of feminine characteristics and costume (Robins 1994). By the middle of the Old Kingdom, very few sculptures exist of women alone. Instead, wives are portrayed kneeling at their husbands' feet and on a smaller scale than their husbands, or seated to the husband's "inferior" left side (Watterson 1991).

Furthermore, individuals were identified in Egyptian art by markers of their social rank in order to locate their position in the Egyptian social hierarchy (Iversen 1975). Scale was used to depict the relative importance of the various individuals; the larger figures represented people of higher social ranking and hence were more important than individuals depicted in smaller sizes (Robins 1994; and compare with observations by Klaus, Shimada et al. this volume). This means that social and hierarchical differences between the sexes were noted in artistic representations by the middle of the Old Kingdom.

Observant Egyptian artists clearly recognized the distinctive nature of the Egyptian body plan, such as the elongated lower leg, and used aspects of these to distinguish between individuals. Identification of the actual in-

dividual being depicted, however, was of lesser importance than identifying that person's position in the Egyptian social hierarchy.

Conclusion: Hierarchy in Egypt as Seen through Stature and Body Size

The formation of the ancient Egyptian state is a classic case study in the rise of social hierarchy and local social stratification in the ancient world. I hypothesized that stature would change over the period of the intensification of agriculture. Similarly, I predicted that sexual dimorphism would increase as a result of greater gender distinction in social roles. In addition, through linkage with the impact of social ranking and hierarchy on males, I expected that variability in male body size would increase. Finally, I predicted that Egyptian painting, sculpture, and architecture would represent these changes. The findings exhibited a mixed pattern of results in relation to these hypotheses. The development of social hierarchy can be identified by an increase in postcranial metric diversity from the Predynastic through the Dynastic periods. This is associated with a change in the pattern of sexual dimorphism and has been linked to changes in gender roles and relations (Zakrzewski 2007b).

The greatest sexual dimorphism in long-bone length and stature was noted during the Late Predynastic era. This is the period when Kemp (1989) hypothesized that the most rapid and intense developments of social ranking and hierarchy would occur (Kemp 1989). It may also be the period when a new centralized hierarchy was imposed and may have been a period of both social and political stress (Wilkinson 1996). Although stature changed for both sexes in the Late Predynastic, the magnitude of stature increase over the period of state formation was greater for males than females. This suggests that males may have had increasingly preferential access to nutrition, fewer episodes of disease, or better medical treatment than females did. The development of Egyptian social hierarchy may therefore have consisted primarily of an increase or change in the social importance of men relative to women over time. This is supported by the greater sexual dimorphism in stature in the individuals of potentially higher social class from the Early Dynastic period than in people from the same period who have been interpreted as poorer individuals.

The current study has demonstrated that bioarchaeology has the potential to elucidate aspects of social hierarchy in Egypt. Further integrating skeletal material with aspects of funerary archaeology, such as funerary ste-

lae or grave goods, will improve greatly our knowledge and understanding of hierarchy, status, and social class in these individuals. The unfortunate reality an investigation such as this encounters is that most of the skeletons included in the current study were excavated more than 100 years ago. Most of the required contextual information, detailed excavation notes, or other records that would permit such an analysis to be undertaken are sadly lacking. Furthermore, much of the Egyptian skeletal remains housed in museum collections consist only of unassociated skulls or postcrania. In addition, at times, only individuals of interest (or portions thereof) were shipped to the European collector or to the museum that was funding the excavation. It should be further remembered that a cemetery sample may not be truly representative of the living population (Wood et al. 1992). It is therefore imperative that, as has already begun at sites such as Hierakonpolis and Amarna, current and future excavations of skeletal and mummified material in Egypt should embrace a bioarchaeological approach. This involves including not only skeletal analysis but also evaluations of associated art, architecture, and the mortuary record to further advance the study of ancient Egyptian social structure and skeletal biology.

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6

Mycenaean Hierarchy and Gender Roles

Diet and Health Inequalities in Late Bronze Age Pylos, Greece

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The Mycenaean archaeological culture was a Late Bronze Age phenomenon that had widespread influence in the Aegean world during the second half of the second millennium BC (on the absolute chronology, see Shelmerdine 2008) and spanned the end of the Middle Helladic through the Late Helladic I–III periods. While the primary centers were located on the Greek mainland (Fig. 6.1), Mycenaean polities were in contact with Minoan polities, elements of the Hittite empire, and Egypt. The first excavators of the Mycenaean culture, working in the nineteenth century, used literal interpretations of classical texts to guide their archaeology. Thus, Heinrich Schliemann, digging at Hissarlik (Troy) and in the famous Grave Circle A of Mycenae (the site he presumed was the home of Agamemnon), believed that he was uncovering the warrior heroes of the *Iliad*.

We know today that the famous epics were products of later times (principally the Dark Age and subsequent periods; Bennet 1997; Whitley 2002) and that they present the Bronze Age through the filter of those times. Mycenae, the fortified citadel that gave its name to the archaeological culture, is itself still an important source of information, but the expansion in the quality and quantity of archaeological data from other sites and regional surveys suggest far greater diversity in the Mycenaean world. While contemporary researchers are using new analytical techniques to investigate questions of exchange, migration, economy, and diet, many perceptions of Mycenaean societies, at least in the public mind, are still influenced by notions of gender roles and hierarchy based in literary sources.

Figure 6.1. Locations of major Greek Mycenaean and Bronze Age sites: (1) Pylos, (2) Mycenae, (3) Tiryns, (4) Midea, (5) Ayios Vasilios, (6) Kalamaki, (7) Ayia Triada, (8) Athens, (9) Thebes, (10) Eleusis, (11) Iolkos, (12) Kazanaki, (13) Knossos, (14) Hania, (15) Armenoi, (16) Atalanti, (17) Modi, (18) Kolaka, (19) Tragana. Map by Anastasia Papathanasiou.

This examination of prehistoric gender and social hierarchy focuses on how archaeological data and skeletal biology studies can be used in concert to reconstruct Mycenaean social roles. While our study is primarily based on data from Pylos, the major center in Messenia in southwestern Greece, we include comparative data from other Mycenaean polities to broaden the discussion and to highlight general aspects of Mycenaean gender relationships. This chapter considers two questions:

- Do the social constructions of rank in Mycenaean societies, as deduced from archaeological data, correlate with any skeletal and dietary differences?
- Are there any gender-based patterns of dental health and diet?

The Nature of Mycenaean Societies

Our knowledge of Mycenaean culture is based on both archaeological data and textual evidence from ancient Mycenaean documents. When the Mycenaean civilization was first rediscovered and defined in the later nineteenth century (McDonald and Thomas 1990), it was assumed that Mycenaeans were hierarchically organized, although over the years the precise form of their societal complexity and its evolutionary development have been hotly debated (Nakassis et al. 2010). The exploration of fortified citadels in the Argolid region at Mycenae, Tiryns, and elsewhere and the discovery of elaborately decorated palatial buildings supported the picture deduced from Greek legends about these places—that they had been ruled by kings (e.g., Hall 1928).

In 1939, Carl Blegen's discovery in the so-called Palace of Nestor at Pylos of the first of over 1,000 accidentally baked clay tablets written by numerous scribes (Bennett 1958; Palaima 1988) paved the way for the decipherment of the script known as Linear B. Sir Arthur Evans had described the characteristics of this script over three decades earlier, after he recognized it in the course of his excavations of the Palace of Minos at Knossos in Crete (McDonald and Thomas 1990). As early as the 1920s there were those who imagined that the language behind the script was Greek (Harland 1923), but there was no proof of that until Michael Ventris's decipherment in 1952 (Ventris and Chadwick 1953). Linear B documents, which include tablets, jar sealings, seals, and marks on ceramic vessels, other artifacts, and walls (Palaima 2011), have as yet been found in only a handful of places in Greece and Crete. Most, but not all, of these sites are assumed to have been cen-

ters of Bronze Age kingdoms. The most extensive textual documents are the tablets, which now number approximately 5,500. They are known from Iolkos (Volos), Thebes, Mycenae, Tiryns, Midea, Ayios Vasilios (Sparta), Pylos, Iklaina, Knossos, and Khania (Nakassis 2013). Tablets were intended to serve only as temporary records (they were unbaked and discarded), and as such, they generally cover the activities of a single year or less. But some information was compiled and rewritten (Bennet 2001), and the insights from the tablets contribute greatly to our understanding of the social and economic operation of Mycenaean centers.

Social Roles

Mycenaean polities encompassed extensive hinterlands from which the leadership exacted surplus through mobilization. Pylos, which was ruled from the Palace of Nestor, controlled a territory of some 2,000 km^2 and a population of about 50,000 that was dispersed over more than 200 settlements of various sizes. The largest of these settlements was around the palace and was home to several thousand individuals (Davis 2010). We know from the tablets that several elite male officials held titled offices (Bennet 2001; Nakassis 2013). A *wanax* (lord or king) presided over affairs of the state, but the full extent of his duties and responsibilities is unclear. He played a role in warfare and probably supplied rowers to the naval fleet. He was a major landholder and provisioned feasts and sacrifices. The principal room of the palace, the megaron, probably held his throne. The *wanax* topped a hierarchy of other officials that included a *lawagetas*, arguably the chief military commander; *e-qe-ta* (followers); and *telestai* (service men). At the local level, a *ko-re-te* (mayor) controlled each of the sixteen principal districts of the kingdom of Pylos (see Nakassis 2013).

Only limited evidence from the tablets provides insight into the roles of elite women in Mycenaean society. Texts make no direct reference to queens, princesses, or other high-ranking women, yet female religious personnel held land grants equivalent to those possessed by elite men (Kazanskiene 1995; Olsen 2014). The Palace of Nestor megaron had only one throne, although there was a separate area, conventionally known as the "queen's quarters," that included a room described as "the queen's megaron" near a luxurious bath (Blegen and Rawson 1966). It is evident that there could have been more than one individual who held an influential position in the palace, but it is unclear if this individual was indeed female or a queen.

The Linear B texts also reveal elements of work and social identity. There were a few occupations held by both men and women. These included religious functions, weaving, and leatherwork (Nakassis 2013; Olsen 2014). Certain workers were directly provisioned by the palace and thus probably were involved in the industries that the palace managed. Adult males and females (and presumably older boys working at specific trades) received equal rations of grain and figs. Younger boys and girls were allotted half the adult amount. This information about worker provisioning at Pylos, which differs from the evidence of rationing for Babylonia and other early states, where adult females were given half the amount that males were given, has been argued to be an indication of Mycenaean social equality (Billigmeier and Turner 1981). However, it is not known if the roles of the rationed peoples mentioned in these different records are directly comparable. Provisioning amounts may be reflective of tasks with different levels of physical activity or they may indicate gender-based statuses.

Women commonly figure in the texts of Pylos as slaves, menial workers such as grain grinders, or as attendants to elites (Olsen 2014). The *e-qe-ta*, or followers, could be assigned slave women. Groups of women who were occupied in the production of textiles and who were recorded nameless with their children were probably slaves—although this has been questioned (e.g., Efkleidou 2002–2003). In any case, the precise nature of slavery in Mycenaean society is unclear. Women in these groups received rations from the palace, but they also may have controlled land. Those in one group are called "captives." Some women are identified by ethnic designations that specified they were of foreign origin, such as the 70 women denoted as *mi-ra-ti-ja* who were associated with the settlement of Milatos in either Asia Minor or Crete (Chadwick 1988; and see discussion in Efkleidou 2002–2003).

Emic differences in Mycenaean constructions of gender and status at Pylos are also reflected in the Linear B text information about parents and their children. Fatherhood is mentioned in conjunction with men having sons engaged in the same trade (Olsen 1998), and some elite males have "patronymics" linking them with their fathers (Nakassis 2013). No parallel designations are found for girls or daughters. Elite female identity seems to have been derived largely from the status of male kin and husbands (Olsen 2014).

Mycenaean monumental art, whether in the form of sculpture, frescoes, or wall paintings, is notable for its lack of depictions of rulers (Shelmerdine

2007). Although the palaces were extensively decorated with frescos and wall paintings, none have ever been conclusively identified as representing kings or queens—in contrast with frescos and wall paintings in other circum-Mediterranean societies such as Egypt and Assyria. Mycenaean males are typically depicted hunting and subduing dangerous beasts, engaging in one-on-one fighting, engaging in combat wearing boar tusk helmets, and riding in chariots. Other men had different roles, such as the famous lyre player perched on the rocks who is entertaining male banqueters or drinkers in a fresco from the Palace of Nestor's main megaron (Lang 1969; McCallum 1987).

As is the case with the art of Bronze Age Greece generally, the women of Pylos are always distinguished from men by their white skin when they are depicted in the palace wall paintings and frescos. Their dress, which has clear similarities to that of the earlier Minoan civilization of Crete (Lee 2000), must have had elite cachet on the mainland. Muskett (2005) suggests that this Minoan-inspired garb was primarily worn for ritual and ceremonial functions. In the wall art, women are represented in nearly as broad a range of activities as men are (Lang 1969). Seated women converse and others walk in processions. The representation of men in processions is less commonly seen. The only known mainland example comes from Pylos (Muskett 2005). In one scene in the vestibule of the main megaron, men carry offerings as a bull is led to sacrifice. The sole woman in this scene may be, in Lang's (1969) view, a priestess or a member of the royal family. Another procession at Thebes (Reusch 1956) shows a line of women bringing a range of small vessels and bundled goods that may have been used in rituals rather than as tribute. Two other wall paintings at the Palace of Nestor depict women; both paintings are large in scale and these women probably represent goddesses. One has a headdress (*polos*) and appears to be approached by a somewhat smaller female ministrant. This is a composition that is found elsewhere in Minoan and Mycenaean art. A second fresco shows a female archer, perhaps the goddess Artemis (Brecoulaki et al. 2008). Linear B texts also mention goddesses and priestesses such as Diwia, a sky goddess like Zeus, and the Olympians Artemis, Poseidon, and Zeus (Duhoux 2008; Palaima 2008).

Although mortal Mycenaean women were associated with childrearing, they were rarely depicted with children. The exception seems to be the relatively uncommon *kourotrophoi* figurines that present women with children. These are typically made of terracotta, although an ivory piece with two women and a child is known from Mycenae (Olsen 1998; Rutter 2003).

Further insight regarding Mycenaean elite gender roles comes from their grave goods. These data suggest separate idealized realms for several activities. In contrast to the frequent depiction of both men and women in palace frescoes and wall paintings, only men are portrayed on artifacts found in the tombs at Pylos, with the notable exception of terracotta female figurines found in three tombs (Blegen et al. 1973; Tzonou-Herbst 2009). The Blegen team found three seal stones and one ring with pictorial scenes. In two cases, single men are shown killing lions. In a third scene, two men are involved in a possible ceremony. A man hunting deer was depicted on a ceramic vessel (Blegen et al. 1973). Similar themes are found at Mycenae. Voutsaki (2004), who made a detailed examination of the iconography and distribution of grave goods in the Grave Circle burials there, argued that even women of high status were excluded from specific activities such as hunting, drinking, fighting, and possibly feasting, as only men were buried with luxury drinking cups. She found no depictions of women in the Grave Circle B grave goods. They do occur in Grave Circle A, but Voutsaki interpreted the female figures on ornaments and the silver Siege Rhyton as "ambiguous and tentative" onlookers rather than active participants in the action (Voutsaki 2004, 359).

Sacrifice, Feasts, and Gender

Linear B tablets, frescoes, and paleobotanical, archaeozoological, and stable isotope studies provide a fairly comprehensive picture of Mycenaean food resources (cf. Halstead and Barrett 2004; Tzedakis and Martlew 1999; Vaughan and Coulson 2000). Zooarchaeological and archaeobotanical data indicate that fishing and collecting were supplementary to pastoral activities (Cosmopoulos et al. 2003). Hunting is frequently depicted in the iconography and epic traditions, but its institutional, social, and political importance outweighed its contribution to subsistence. Although fish are frequently mentioned in the archaeological record of Greece (Doumas 1992; Powell 1996), they are notably absent even in Mycenaean coastal site fauna assemblages (Cosmopoulos et al. 2003). The emphasis was on domestic animals whose respective importance varied over time. Cattle are more common in the Early Bronze Age, but they declined thereafter, while the use of ovicaprids increased. Pig use remained at a lower but constant frequency (see Kotjabopoulou et al. 2003).

Animal sacrifice and feasting were important components of Mycenaean palace life. The archaeological evidence of sacrifice, though once debated, is now clearly documented through detailed faunal analyses (Cosmopoulos

and Ruscillo 2014; Halstead and Isaakidou 2004). Some Linear B tablets contain lists of goods that were sent to the palaces for these purposes. Certainly some sacrificial rites occurred in the palaces, and scenes of sacrifice and ritual processions are part of the wall decorations, as described above. The megaron of the Palace of Nestor had an elaborate central hearth, a round low "table of offering" with associated miniature *kylikes* (drinking cups), and a curious dumbbell-shaped trench by the throne base that was probably used to capture libations poured by the *wanax* (Blegen and Rawson 1966). Further evidence of sacrifice comes from detailed examinations of stratified faunal deposits from specific locations in the Palace of Nestor. Burnt cattle remains in the archives room might have been brought there for a scribe to verify that a sacrifice had indeed occurred (Stocker and Davis 2004). The bones show clear evidence of butchery and the meat from this one sacrifice alone would have provided food for nearly 1,000 people. Other feasts might also have fed thousands (Isaakidou et al. 2002; Halstead and Isaakidou 2004).

The Palace of Nestor had open courtyards and adjacent ceramic storerooms that might have been built especially for communal activities. Some of these storerooms were filled with wine containers and wine cups (Blegen and Rawson 1966; Galaty 2007). Hruby's (2006) analysis of one storage complex revealed that the wine cups were mass produced and functioned as Mycenaean "Dixie cups," disposable plainwares designed for public drinking and feasting. Faunal remains and drinking cups found in the larger tombs at Pylos (Blegen et al. 1973) provide evidence of funereal meals or feasts as part of mortuary rites.

While sacrifice and feasting were clearly essential elements of Mycenaean public life, we cannot determine who the participants were or the full functions of these rites (Wright 2004a, 2004b). Were feasts merely religious or celebratory in nature or were they also important arenas where political and economic alliances were formed or enacted (see Borgna 2004; Nakassis 2012; Palaima 2004)? Did they serve as vehicles for military recruitment (Fox and Harrell 2008)? Were smaller meals or drinking parties with tables of dining pairs the exclusive activities that cemented relationships among Mycenaean elites? Such settings are depicted in wall paintings in the Palace of Nestor's main megaron and are mentioned in the Ta series of tablets as a set of 11 tables and 22 seats (Killen 1998; but see Shelmerdine 2008, who argues that the 22 "seats" included both seats and footstools). Priestesses had important roles in certain sacrifices (Olsen 2014; Palaima 2004), but we do not know the extent to which women were party to the feasts.

Few scholars have investigated the participation of women in feasting, even though Mycenaean feasting has been the subject of much recent research (see *The Mycenaean Feast*, a special issue of the journal *Hesperia* [Wright 2004a]). The Ta tablets from Pylos list footstools in the inventory of feasting goods (Palaima 2004), and these are associated with women in Mycenaean iconography, including the White Goddess fresco at Pylos (Rehak 1995). Both women and men at Pylos were involved in the cultic processions that likely preceded certain banquets, as is depicted on the walls at the Palace of Nestor (Palaima 1995). There is some evidence that women might have participated in celebrations involving public drinking, but the important distinction may be that women did not feast with the men (Wilson 2008). Even lower-status men are mentioned as receiving portions at some feasts, but there is no mention of this for women (Olsen 2014). Thus, many scholars view males as the principal players in the power realm of feasting (Nakassis 2012; Wright 2004b). The Linear B texts indicate that men sponsored feasts and that women's roles usually involved food processing (Olsen 2014).

Men, Women, and Mortuary Behavior

Mycenaean forms of burial reflect the social hierarchy as independently suggested by the physical and textual evidence (Cavanagh 2008; Cavanagh and Mee 1998). The famous Grave Circles of Mycenae contained richly appointed shaft graves, an early tomb type that is represented by only a single example at Pylos. During the height of the palace system, the largest and most elaborate burials involved the *tholos* (or beehive) tomb forms. These were covered with mounds of earth and thus constituted significant features of the built environment. Chamber tombs were far more common and more broadly distributed. These typically consisted of a chamber of moderate size cut into soft bedrock on a hillside and were reached through a narrow passageway, or *dromos*. Both types of graves were reused on multiple occasions; bones and goods from earlier inhumations were moved and redeposited in the tombs. The richness and complexity of burial assemblages in chamber tombs varied. Tombs were arranged in clusters (cemeteries) that likely reflected kin groupings. Architecturally simpler cist graves (slab-lined pits) and pit graves are also found. The use of different tomb types varied greatly by locality and may have been affected by constraints of the terrain. The significance of these tomb distributions, the temporal framework for the construction of *tholoi*, and the association of tomb type with ranks in the Mycenaean social hierarchy is the focus

of much research and discussion (Boyd 2002; Cavanagh and Mee 1998; Dickinson 1983; Lewartowski 2000; Schepartz et al. 2009; Zavadil 2013). In general, based on the quality of grave goods, it appears that the simple pits and cists can be associated with lower strata of Mycenaean society. The difference in the quality of grave goods between "rich" chamber tombs and *tholoi* is not as clear, as there is overlap in the presence of certain prestige materials and the true richness of many tombs will never be known because of the widespread tomb looting that took place in antiquity and later times. This problem of differentiating "rich" chamber tombs from *tholos* tombs also persists when overall energy expenditure is the evaluation criterion, as there are large, elaborate chamber tombs with carved side niches that dwarf some *tholoi*, such as those at Ellinika (Malapani 2014).

The Trouble with Mycenaeans

Several factors complicate the study of Mycenaean tombs. It is sometimes difficult to classify the tombs by type because of later disturbances and the reuse of stone blocks. At Pylos, the "Grave Circle" is most likely a disturbed *tholos* and is not analogous to the Grave Circles at Mycenae (Davis et al. 1997).

Mycenaean tomb contents are most frequently complex assemblages of commingled artifacts and bones. The richness of the tombs encouraged grave robbing, even in antiquity. Evidence of plundering is abundant, and few of the larger *tholos* tomb assemblages are found intact. These activities did not generally seem to entail removal of skeletons. Many tombs appear to have been ransacked; bones, beads, and small items are strewn over the ground. Tholos IV at Pylos contained large amounts of gold leaf in the central portion of the floor—so much that the Blegen team initially thought there was gold-leaf flooring (Blegen et al. 1973). This gold may have originally covered wooden furniture or other perishable materials; at Mycenae it has been inferred that young high-status children were wrapped in golden cloths (Gradziadio 1991).

Grave robbers are not the only individuals who might have displaced or removed tomb contents. There is substantial evidence of deliberate and systematic disturbance in tombs by Mycenaeans themselves. The root cause was the practice of secondary burial. Chamber tombs, shaft graves, and *tholoi* were routinely reopened to add new individuals. This usually involved clearing the *dromos* and removing the stones blocking the chamber entrance. The existing burials, including grave goods, were moved to the side or placed in side niches. Many tombs contain widespread burnt deposits

or ash, suggesting that burning was often part of the cleaning ritual. Larger tombs sometimes had utilitarian ceramic vessels and varied in the form of interment; the earliest *tholos* burials at Pylos were apparently secondary burials, as inferred from their very incomplete nature. Remains were redeposited in large jars, although some individuals were in pits or cists. In later periods, tombs often were found to contain one individual in an extended position (presumably the most recent burial) and commingled secondary deposits of bones from the previous burials (Blegen et al. 1973). These secondary burials are fragmentary and are particularly difficult to analyze. In most cases, it is impossible to associate crania with postcranial bones.

Early excavators tended to routinely attribute the chaotic state of Mycenaean tomb contents to the effects of looting (cf. Blegen et al. 1973). However, a study of looting and secondary disturbance at Pylos conducted by Murphy and Schepartz found that all tombs, regardless of their richness, have evidence of secondary disturbance where multiple burials were identified. Thus, it can be inferred that Mycenaean mortuary ritual involving secondary burial and potentially the removal of valuable grave goods, and not looting, was the key factor in creating the commingled assemblages. Some of the best unequivocal evidence of the deliberate removal of objects comes from the bones themselves. Although some human bones have sizeable areas of oxidative staining from contact with metallic objects (i.e., stains on skeletal elements consistent with the known practices of placement and positioning of mirrors or weapons), no metal artifacts were recovered from the tomb.

Perhaps the most critical factor that complicates Mycenaean tomb studies is that we have no evidence of the majority of the Mycenaeans. Three *tholoi* (including the Grave Circle in this group) were constructed near the Palace of Nestor and several others were built in outlying settlements of the kingdom (Bennet 1995; Boyd 2002; Davis 2010). Chamber tomb cemeteries were discovered in the hills surrounding the palace, but only two simple pit or cist graves have been identified (Blegen et al. 1973). In the vicinity of the Palace of Nestor, there are 15 tombs (three *tholos* tombs, 11 chamber tombs, and one simple tomb) (Table 6.1) with human remains and detailed archaeological contexts spanning the end of the Middle Helladic period through the Late Helladic (LH) IIIC, after the destruction of the palace. Most of the tombs were used for hundreds of years. The ceramic chronology and the relative frequencies of different vessel types indicate that the cemeteries and *tholos* tombs were used with differing intensity over time. Our earliest evidence, from MH III–LH I, comes from the Grave Circle and Tholos IV.

Subsequently, the Tsakalis chamber tomb cemetery and Tholos III were constructed. In LH II, there was intense mortuary activity in Tsakalis E-8 and E-9 and the Grave Circle and limited use of Tholos III and Tholos IV. During the earlier palatial period, LH IIIA, there was minimal use of the Grave Circle and Tholos IV, but three new tombs were opened in the Tsakalis cemetery and were used intensively during this period. This was also the time when Tholos III was most heavily used. By the later palatial period, LH IIIB, the Tsakalis cemetery, the Grave Circle, and Tholos IV were not in use. The evidence of burial activity is sparse during the later palatial period, LH IIIB and LH IIIC Phase 1, which were the high points of the palace's development. Only the Kondou, Kokkevis, and Tholos III tombs have evidence of activity, albeit limited, in LH IIIB. Tholos III continued to be used during LH IIIC Early (Murphy 2014). Analysis of the more recently excavated Kokkevis and Kato Rouga chamber tombs should help further refine this chronological picture.

Another important consideration for Mycenaean studies is that there is an obvious chronological mismatch between texts and material culture, not only at Pylos but also throughout the Mycenaean world. Most Linear B documents date to the final months in the lives of the palaces in the thirteenth-century-BC paintings on the walls of the Palace of Nestor and tablets found in dumps around the palace and thus cannot supply a picture of Pylian society earlier than the latest phases of the settlement. Mortuary analysis is thus the primary means of shedding light on social and political hierarchy in preceding centuries. However, we can never know the age and sex of those buried in tombs in some of the most significant Mycenaean cemeteries, since their excavators discarded the human skeletal remains or they were not preserved. Can the presence of weapons be used to identify male burials? Are mirrors associated with female burials? Commonsense assumptions of this kind cannot be objectively evaluated.

Despite the constraints imposed by the practice of secondary burial and taphonomy discussed above, it is possible to examine questions of social status and gender at Pylos. The differences in tomb type and diversity of grave goods among the burials can be used as basic indicators of rank in the polity. While subsequent analyses will be conducted using more precise measures of tomb "richness" (such as the presence of rare or imported goods, the use of royal insignia, and calculations of grave goods/number of burials), it is logical to begin our inquiries with the broad classifications that have been more generally employed in Mycenaean studies. Therefore, the tomb form (*tholos*, chamber, or simple) will be the proxy for hierarchical

rank in this study. For gender, we use the proxy of biological sex, although we realize that this may be incorrect for some individuals: without clear associations between individuals and grave goods in the Pylos tombs, this particular relationship cannot be examined. As almost no simple graves are known at Pylos, it is likely that an entire stratum of the society, and probably the most numerous, is not represented.

The importance of skeletal biological analysis for expanding our knowledge of Mycenaean society and testing questions that arise from the archaeological data is thus clear. The Blegen team recorded detailed information about the nature and history of the settlement at the Palace of Nestor during the entire Mycenaean period. Although the excavations were conducted over fifty years ago, Blegen and his colleagues were careful to preserve skeletal remains and to record their contexts. New excavations of other chamber tombs in the Kato Rouga and Kokkevis cemeteries by Malapani contribute to the corpus of this skeletal data. Pylos thus provides extraordinary opportunities for researchers that are unparalleled at other palatial sites in the Mycenaean world.

Materials and Methods

Skeletal Sample

The human skeletal materials from 15 tombs are included in this analysis. A total of 179 individuals were identified. Our study focused on the dental remains because they are the best-preserved elements. To maximize our analytic potential, we assessed both individual teeth ($N = 946$; $N_{chamber} = 704$; $N_{tholos} = 242$) and 96 partial or complete adult dentitions ($N_{chamber} = 67$; $N_{tholos} = 29$).

The bones from each tomb were cleaned (some skulls were still *en bloc*) and compared to the excavation notebook information and published descriptions. In most cases the crania were clearly labeled, but this was not the case for the Grave Circle. After reconciling the materials with the documentation, any remaining skull elements were given new designations. Loose teeth were not recognized as separate individuals unless they belonged to an age cohort not represented by the known skulls. Following this, the major long-bone fragments were sorted, first according to the labels and then in terms of identifying possible paired elements. Taphonomic characteristics and bone morphology were considered in making these associations. Unless they were clearly associated during the process of excavation, it was

Table 6.1. Minimum number of individuals (MNI) and sex distribution in Pylos tombs

	MNI	Females	Males	Indet.	Subadults
Tholoi					
Tholos III	12	4	4	2	2
Tholos IV	13	3	3	7	0
Grave circle	31	12	9	10	0
Chamber tombs					
Tsakalis E3[a]	2	1	1	0	0
Tsakalis E4	2	0	1	0	1
Tsakalis E6	19	7	6	1	5
Tsakalis E8	16	4	4	7	1
Tsakalis E9	9	4	4	0	1
Kondou	9	4	2	1	2
Kokkevis 2	19	3	11	2	3
Kokkevis 3	1	0	1	0	0
Kato Rouga 1	1	0	1	0	0
Kato Rouga 2	2	0	1	1	0
Kato Rouga 4	17	5	6	5	1
Kato Rouga 5	26	11	7	5	3
Total	179	58	61	41	19

[a]This is the only "simple" tomb. It is part of a cemetery of chamber tombs where some tomb constructions were abandoned due to poor soil and bedrock conditions. It may therefore be a thwarted attempt at chamber tomb construction, and it is included with the chamber tombs in the analyses presented here. Treating it as a separate rank does not noticeably affect the results.

not possible to match any cranial material with postcrania. In most tombs, the number of skulls proved to be the best determinant of the minimum number of individuals (MNI), although a few additional individuals were recognized from postcranial elements alone when the number of certain elements or the presence of unique characteristics indicated that an additional individual was represented. This was the first time an extensive analysis of the entire Pylos assemblage was conducted, and the resulting MNIs for most tombs (Table 6.1) were increased over those estimated by Angel (Blegen et al. 1973).

Methods of age and sex estimation used in this study were largely determined by bone preservation. There were few pelvic remains, so sex estimation was therefore largely dependent on skull morphology (following Buikstra and Ubelaker 1994) and metric comparisons of femoral heads and

midshafts. A combination of age estimation techniques based on the morphological changes of the pubic symphysis and the auricular surface, dental development, the degree of epiphyseal union, tooth wear, and sutural closure (Buikstra and Ubelaker 1994) were applied. The greatest weight was given to the first four methods because they yield more precise estimates. However, seriation of tooth wear was often the only method applicable to poorly preserved burials. For this reason, ages estimated from tooth wear were carefully reevaluated as the study progressed. The method for assessing wear is derived from the techniques of Miles and Molnar, as discussed in Hillson (1996). Specific age estimates were achieved for the cases where dental development and skeletal maturation made more precise aging possible, but individuals were most frequently assigned to age cohorts of five- or ten-year spans. Few older adults could be aged with any precision beyond 45 years. General age cohorts were created after the analysis was complete. As these are arbitrary divisions of the sample, they vary according to the question under investigation.

The estimation of sex and age for fragmentary remains is naturally subject to certain biases. To minimize these, all estimates were done by two analysts (Miller-Antonio and Schepartz) and differences in sex estimation were scored as indeterminate. The use of broad age cohorts minimized bias in age estimation. The entire collection was reevaluated after all individuals had been assessed to incorporate the full range of variation in the estimations.

The focus of the dental analysis was fourfold. All teeth were identified and mesial-distal and buccal-lingual measures were recorded. The pathological assessment included recording linear enamel hypoplasias, dental caries, alveolar abscesses, antemortem tooth loss, and agenesis. Hypoplasia, which was assessed by visual inspection and thumbnail resistance (Steckel et al. 2006), was denoted as present or absent and the degree of expression was ranked on a scale of slight, moderate, or severe. The presence of dental caries was tallied by individual teeth. This count includes crowns or roots with active caries and teeth that had clearly been lost to infection related to dental caries. The latter were teeth adjacent to or occluding with carious teeth where the decay process involved several teeth in the dentition. If no other evidence of dental caries was present, these teeth were counted only as antemortem losses. Teeth were judged as having been lost antemortem when alveolar bone exhibited substantial remodeling such that the original forms of the sockets were no longer present. Agenesis was assessed visually and not radiographically. The total dental sample includes both teeth that

were present and those that were missing where antemortem status could be assessed from the condition of the alveolus. Units of analysis included individual teeth and dentitions.

Indicators of dental health provide insight into general health status, childhood biological stress, and general dietary quality. If tomb type and therefore social rank correlates with access to resources during life, then we would expect to see evidence of differential nutritional access at Pylos. Individuals from the *tholos* tombs should have diets with higher levels of protein (including meat from wild and domestic animals, dairy products, and pulses) and be less dependent on carbohydrate-rich cariogenic cereals. We would thus expect *tholos* tomb individuals to show less dental pathology than individuals buried in chamber tombs.

Stable Isotopes

Tooth or long-bone samples from 67 individuals were collected for dietary analysis using stable isotopes. Carbon isotopes are used to distinguish between three major dietary categories: marine resources, C_3 plants (including most leafy plants, temperate grasses such as wheat and rice, trees, shrubs, nuts, and fruits), and C_4 plants (such as tropical grasses, maize, sugarcane, millet, some amaranths, and some chenopods) (see Schoeninger et al. 1983; Schoeninger and DeNiro 1984; Richards and Hedges 1999; Schwarcz 2000). Nitrogen isotope ratios distinguish between different trophic levels, especially between marine and terrestrial protein consumption. Consumers of terrestrial foods generally have less positive values than consumers of marine foods. The methods of sample preparation and isotopic analysis are detailed in Papathanasiou et al. (2012).

Statistical Analysis

Frequencies of traits or pathological conditions were dichotomized and contingency tables were constructed. The differences in frequencies were evaluated for statistical significance using Fisher's exact tests, as is the common practice with small sample sizes (Larntz 1978). The isotope values were compared using Student's *t*-tests.

Results

Skeletal Evidence for Mycenaean Gender and Hierarchy

Demography

The Pylos tombs included only 19 subadults (10.6 percent of the sample). None of the individuals in these tombs were infants or children younger than four years of age (Table 6.1). Children are better represented at other Mycenaean sites. For example, they constitute 32.2 percent of the Athenian Agora Mycenaean burials (Smith 1998) and 23 percent of the East Lokris (Atalanti, Tragana, Kolaka, and Modi) skeletal samples (Iezzi 2005). Clearly, the Pylians practiced preferential burial of adults. In addition to the issue of missing children, the number of adults recovered is remarkably fewer than the estimate of ca. 2,500 individuals living at and in the immediate vicinity of the palace, based on information from the tablets, the size of the town on the Englianos ridge, and population densities of historic Messenian villages (see discussion in Stocker and Davis 2004). This estimate is only for the community ca. 1200 BC. Certainly many more people lived and died in the vicinity of the Palace of Nestor during the centuries than are documented by the tombs.

J. Lawrence Angel studied portions of the Pylos skeletal sample in the 1950s. Although he never formally published his analysis, the age and sex estimates were included in the monograph on the palace and the immediate region (Blegen et al. 1973). Angel found evidence of many more adult males than females (20 males and 7 females) in the Pylos Grave Circle. Because the tomb also included many weapons and bronze objects, it was interpreted as reaffirming the notion of a Mycenaean society focused on the actions of elite warriors as exemplified by the Mycenae grave circles. Reexamination of the entire Pylos collection, including unstudied material from the Blegen excavations and more recently discovered chamber tombs in the Kato Rouga and Kokkevis cemeteries, yields a different result (Table 6.1). Because of the fragmentary nature of the sample, sex or age estimation was not possible for many individuals (approximately 23 percent).

With the exception of the greater number of subadults in chamber tombs (13.8 percent compared to 3.6 percent of *tholos* burials), the proportional representation of the different age cohorts is similar for the two tombs types at Pylos (Fig. 6.2). The largest cohorts are young adults (19–30 years).

The proportion of males and females does not differ substantially by tomb type (Fig. 6.3). Kokkevis 2 is the only tomb for which males greatly

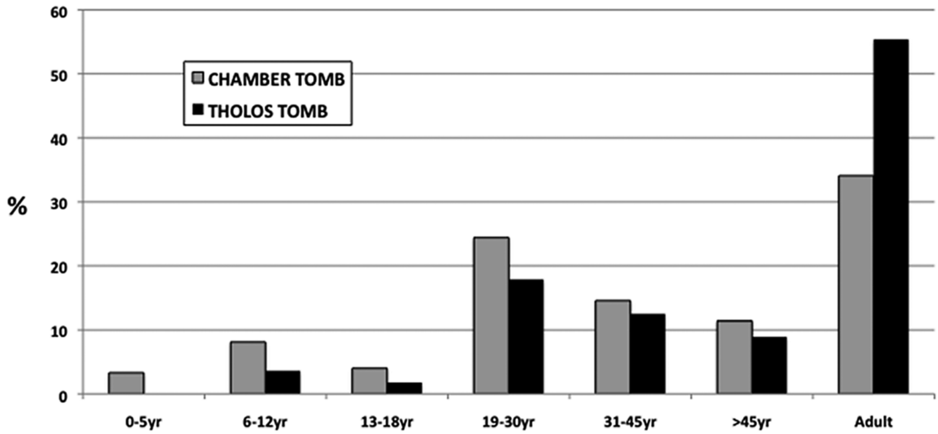

Figure 6.2. Proportional representation of age cohorts by tomb type at Pylos. The category *Adult* refers to fragmentary adult individuals not assigned to specific age cohorts.

outnumber females. The Grave Circle contains a number of very fragmentary and indeterminate remains, but these are not the individuals that Angel sexed as males. The overall equal distribution of males and females suggests that these are family tombs, in the sense that the adult members of families were buried together. Angel's early argument for preferential burial of males is also contradicted by the equal representation of adult males and females in other Mycenaean cemeteries (cf. Smith 1998; Iezzi 2005).

Both age and sex estimates are possible for 71 (44.4 percent) of the adults. The distribution by tomb type (Fig. 6.4) is noteworthy. In the chamber

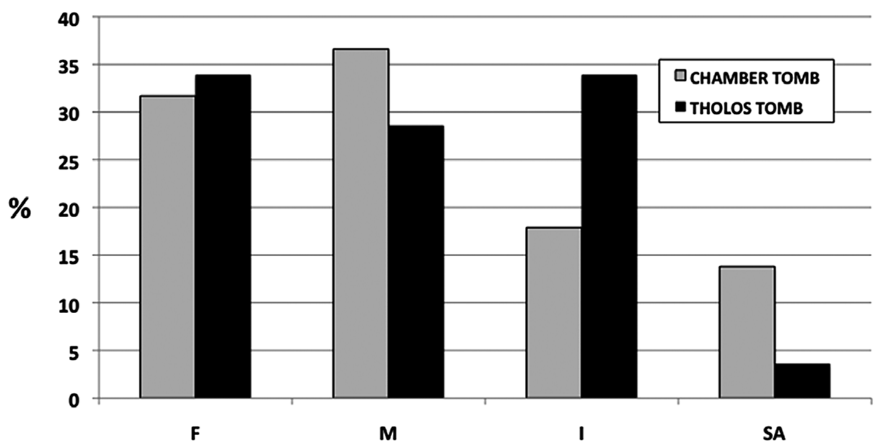

Figure 6.3. Proportional distribution of sex by tomb type at Pylos. F: Female; M: Male; SA: Subadult; I: Individuals of indeterminate sex estimation.

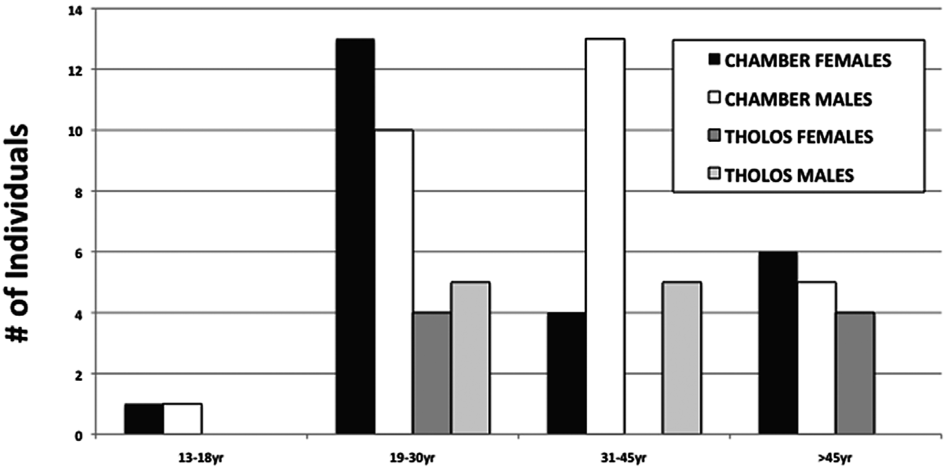

Figure 6.4. Individual counts for age cohorts at Pylos.

tombs, there are more younger females (aged 19–30 years), while the representation of younger and middle-aged males (aged 31–45 years) is virtually the same. No middle-aged females or older adult males were identified from the *tholos* tombs.

Differential Health by Tomb Type and Sex

We first examined the distribution of dental caries, antemortem tooth loss, and linear enamel hypoplasias in order to evaluate differential health among the Pylos individuals. The total prevalence of dental caries (27.3 percent) is very high when individual teeth are the unit of analysis. Carious dental lesions were always associated with antemortem tooth loss in individuals over 22 years of age. Tooth loss was not necessarily associated with heavy tooth wear. It also characterized young adult individuals who had lost their M1s to advanced dental caries. Infection of the pulp chamber from advanced dental caries with resultant tooth loss was obviously a serious problem for this population, as 15.9 percent of all teeth were lost antemortem. Fairly high rates of dental caries and antemortem tooth loss have been reported for other Mycenaean populations. For example, in a study of Ayia Triada in the western Peloponnese, Tsilivakos et al. (2002) reported 17.88 percent antemortem tooth loss and 7.7 percent caries. Unfortunately, direct comparisons with studies by other researchers, including Angel, are not possible due to methodological and recording differences.

Finally, linear enamel hypoplasias were relatively common; they occurred in 35 percent of the Pylos sample. Almost all of the affected individuals had only very slight expressions of the pathology.

Dental health was also examined for the different tomb subsamples. Here we found important differences. Notably, teeth from the *tholos* burials had low frequencies of both dental caries (6.6 percent) and antemortem losses (2.1 percent). In contrast, 34.4 percent of the chamber tomb teeth had dental caries and fully 20.6 percent were lost antemortem. This is a very significant difference between the *tholos* and chamber tomb frequencies for dental caries and antemortem losses; the frequencies of both conditions are significantly higher for the chamber tomb subsample (Fisher's exact test, one-tailed, $p < 0.0001$ for both tests).

The teeth that constitute an individual's dentition are exposed generally to the same stresses and intraoral environment during their formation and functional life. Thus, the frequency of dental pathology is highly correlated in a dentition and it is more precise to use dentitions as the unit of analysis. The differences between the *tholos* and chamber tomb dentition frequencies for dental caries and antemortem loss are again highly significant (Fisher's exact test, one-tailed, $p < 0.0002$ and 0.0003, respectively); these conditions affected many more chamber tomb dentitions. The same result is not found for enamel hypoplasias, for which the frequency does not differ significantly by tomb type.

The examination of dentitions also enables us to compare males and females. There are 57 dentitions with associated cranial/postcranial sex estimations (17 chamber tomb females, 25 chamber tomb males, 6 *tholos* tomb females, and 9 *tholos* tomb males) to compare. Across tomb types, females have significantly more dental caries and antemortem tooth losses than males (Fisher's exact test, one-tailed, $p = 0.0176$ and 0.0383, respectively). Again, hypoplasia frequency differences are not statistically significant. Chamber tomb females have the highest frequencies of dental caries and antemortem loss (88.2 percent and 70.6 percent, respectively) and the difference is statistically significant (Fisher's exact test, one-tailed, $p = 0.0475$ and 0.0289, respectively) when compared to their male counterparts. The highest crude prevalence of enamel hypoplasia occurs in the chamber tomb males (52 percent). Our results indicate that there are major differences in the dental health of males and females at Pylos and that these differences are also correlated with tomb type.

How does the dental health of the richer and poorer chamber tombs compare? The Tsakalis E6 tomb stands out as having more valuable and

more numerous grave goods; these goods rival the wealth that is present in the *tholos* tombs (Blegen et al. 1973). If mere wealth is the factor underlying the differences in dental health identified here, then the individuals in Tomb E6 should be similar to the *tholos* burials and different from the other chamber tomb burials. Tomb E6 is an unusual chamber tomb in other ways. It has the greatest number of preserved subadult remains (N = 5) and the greatest number of interments. The majority of these individuals, including the children, have poor dental health. The overall dental caries frequency for E6 is not significantly different from that of the other chamber tombs (Fisher's exact test, one-tailed, p =0.3588), but it is statistically different from the *tholos* tomb frequency (Fisher's exact test, one-tailed, p <0.0001), just as the frequency of antemortem tooth loss (Fisher's exact test, one-tailed, p =0.004). This is an interesting result, given the richness of this tomb. The poor dental health of the individuals in the tomb could be the result of greater access to certain nutritional resources, such as greater proportions of high-carbohydrate cariogenic foods in their diets and less access to the animal protein resources that may have characterized the diets of *tholos* tomb individuals. At the same time, individuals buried in this chamber tomb apparently had greater access to some of the types of grave goods found in the *tholos* tombs, namely items made of bronze, gold, and ivory. Hence, this tomb might belong to a larger kin group with more personal capital and collective resources or it might illustrate an attempt to raise the status of the family that built it through funerary ostentation. These results for E6 suggest that access to material wealth was not the critical factor that affected dental health at Pylos. Social rank and gender were more important.

Differential Diet and Stable Isotope Results

Could social constructions of rank and dietary differences be the source of the disparities in dental health at Pylos? Did females have poorer quality diets and did social rank also play a role? To address these questions, we conducted stable isotope analyses to determine the variability in carbon and nitrogen levels in Pylian diets. Unfortunately, bone preservation was very poor, and only 39 of our 67 samples yielded valid results. All samples cluster in the C_3 terrestrial diet range. Cereals would have provided the largest amount of carbohydrates, legumes would have been a primary source of plant protein, and domesticated animals and their secondary products supplied the majority of the animal protein. Marine resource consumption seems minimal.

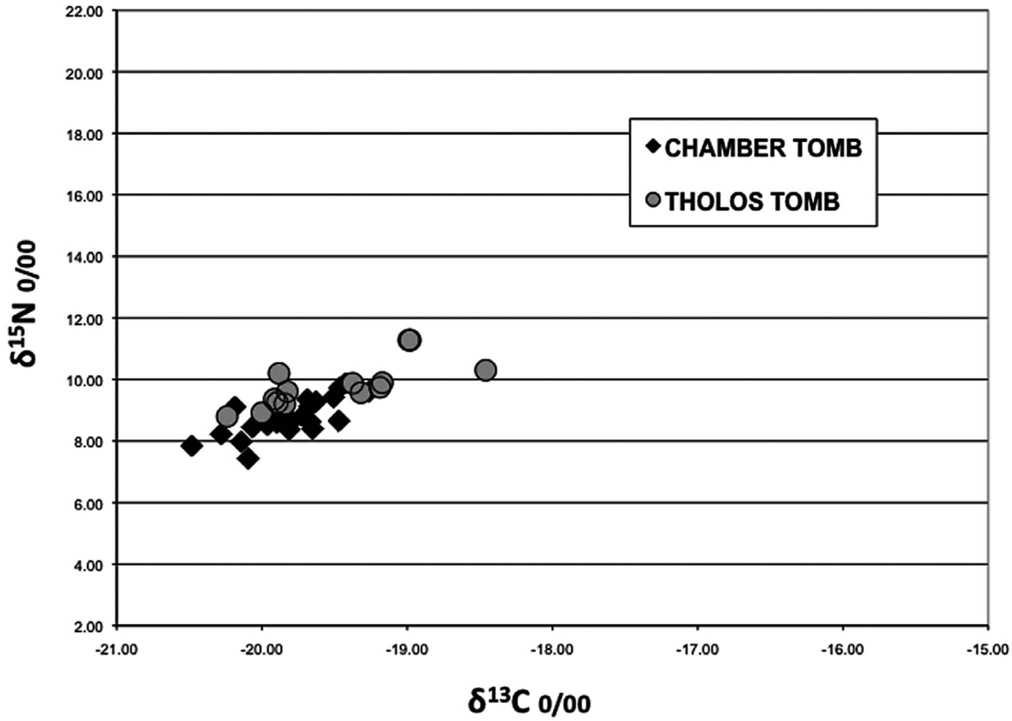

Figure 6.5. Isotope data from Pylos *tholos* and chamber tombs.

When the different subgroups at Pylos are compared, increased variability is revealed. When we compared the individuals from the *tholos* tombs with chamber tomb individuals (Fig. 6.5), they showed greater consumption of animal resources. This is statistically significant (*t*-test, two-tailed, $p < 0.0005$ for nitrogen levels) despite the small sample size. The *tholos* tomb individuals exhibit some of the highest values of the entire sample. The difference becomes more marked when only adult individuals from *tholoi* and chamber tombs (Fig. 6.6) are compared (*t*-test, two-tailed, $p < 0.05$ and < 0.0005 for carbon and nitrogen, respectively). The difference remains statistically significant (Fig. 6.7) when only females from *tholoi* and chamber tombs are compared (*t*-test, two-tailed, $p < 0.05$ for nitrogen), though it is not significant when males are compared. Additionally, when we compared males and females from the chamber tombs (Fig. 6.7), we observed a statistically significant difference (*t*-test, two-tailed, $p < 0.005$ for nitrogen) in the amount of animal protein consumed; females showed less animal protein in their diet. This does not hold true when males and females from the *tholoi* are compared (Fig. 6.7), perhaps due to the small

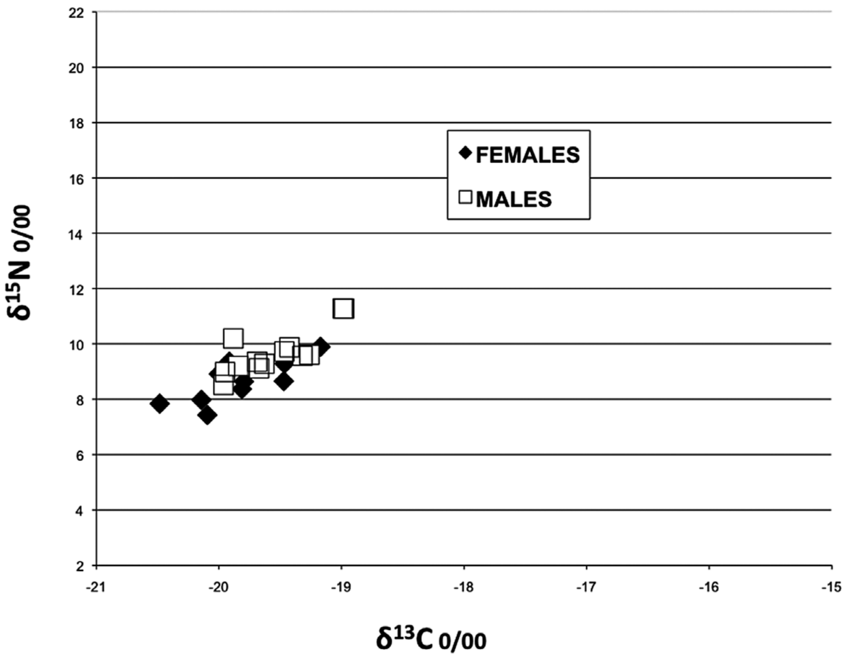

Figure 6.6. Combined isotope data for Pylos males and females from *tholos* and chamber tombs.

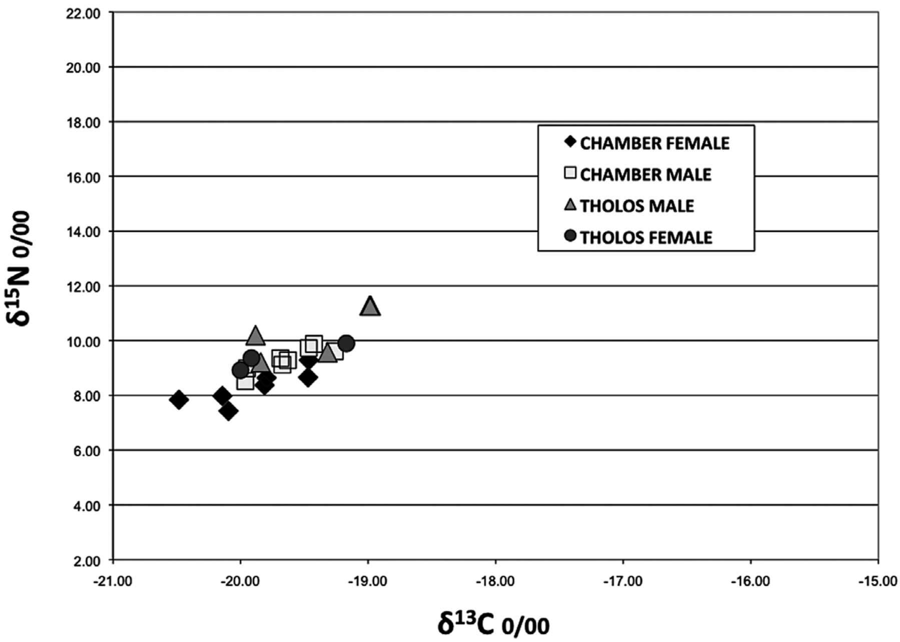

Figure 6.7. Individual isotope data for Pylos males and females from *tholos* and chamber tombs.

sample size. These dietary data clearly substantiate the results from the osteological analysis. The immediate impression is that the life experiences were different for Mycenaean males and females. Individuals in the *tholos* tombs seem to be distinct from people buried in chamber tombs in terms of better long-term nutrition and superior dental health.

Discussion

Our skeletal and isotope studies support the archaeological and textual evidence of hierarchical gender differences at Pylos. The social system resulted in significantly poorer dental health for Pylian women relative to males. This difference occurs in both the *tholos* and chamber tomb subsamples; males from *tholos* tombs had the fewest dental caries and antemortem tooth losses, while females from chamber tombs exhibited the highest frequencies of those conditions. The staple isotope data show the same patterns: *tholos* tomb males had the highest levels of animal protein in their diets.

We are viewing the Pylians from the perspective provided by the burials of the elite members of the society. Skeletal data from other Mycenaean localities may help characterize the broader social structure. A useful comparison with Pylos is the Mycenaean period cemetery in the Athenian Agora. The Agora tombs represent approximately the same temporal range as our Pylos sample (Immerwahr 1971). The Agora burials contrast with the Pylian tombs in two important ways: there are many more children and the tomb types include only chamber tombs and simple graves. No *tholos* tomb has been definitively located in the Agora, so the upper social stratum, based on tomb type, is missing. The sample includes 979 teeth from 57 individuals. The overall frequencies for dental caries and antemortem tooth loss (with individual teeth as the unit of analysis) are 27.1 percent and 17.7 percent, respectively. These frequencies are almost identical to the results for Pylos. In addition, as expected, the teeth of chamber tomb individuals have fewer dental caries and antemortem losses than individuals in simple pit graves, and the dental health females in both tomb types was worse than that of their male counterparts.

The dental health situation in the Agora is perhaps not a simple case of a population one step down the ladder of Mycenaean rank from the individuals at Pylos. If this were true, we would expect the frequencies of dental pathologies for the chamber tomb groups at both sites to be similar. Yet the chamber tomb individuals in the Agora have significantly less oral pathology than the chamber tomb individuals at Pylos (Fisher's exact test,

one-tailed, p =0.0003). These differences still exist when corrections are made for age of the individuals in the subsamples. The difference in dental caries prevalence between the females (Pylos chamber females compared to Agora chamber females) is more significant than the difference between the males (Fisher's exact test, one-tailed, $p < 0.0001$ and $p = 0.0130$, respectively). Even so, the dental health of males from the Agora chamber tombs is poor and is certainly not comparable to the healthy *tholos* tomb individuals at Pylos. Thus, it is possible to posit that gender differences were commonly shared and perhaps relatively rigidly constructed across Mycenaean groups, but the nature of the social hierarchy probably involved considerably more variability than might be inferred from tomb types alone.

How do the isotope results from Pylos compare with other Mycenaean sites in Greece? The cumulative isotope data sample for Bronze Age Greece, although not extensive, covers all subperiods and includes the two most important palatial centers of the Mycenaean world (Mycenae and Pylos) in addition to a number of smaller rural sites from a broad geographical area. The stable isotope data from Pylos compare well with data from other Bronze Age sites in Greece, which exhibit the same C_3 terrestrial diet with no significant marine protein consumption. All the values of individuals buried in chamber tomb cemeteries are similar, yet at Mycenae, individuals in the "royal" tombs (Grave Circles A and B) have significantly greater quantities of animal and fish protein in their diets (Richards and Hedges 1999). The differences between chamber tomb individuals and *tholos*/ Grave Circle individuals are statistically significant and indicate variable consumption practices that appear to mirror early status differences. In another Mycenaean context in Achaia, Vika (2002) observed a correlation between individuals buried in more elaborate tombs and elevated $\delta^{15}N$ values, but the sample size was extremely small. Another parallel comes from the periphery of the Mycenaean world, at the site of Kazanaki in Volos, coastal Thessaly, where a small, rich *tholos* tomb was found. In this case, the two valid samples exhibit the highest nitrogen values for Bronze Age Greece (Adrymi-Sismani and Alexandrou 2009; Papathanasiou 2009). Finally, isotope results for the site of Armenoi from Late Minoan Crete also indicate that males incorporated significantly more animal protein in their diets (Richards and Hedges 1999).

Thus, the gender- and social status–based hierarchy at Pylos appears to be representative of a more widespread Mycenaean system, as demonstrated by the isotope data, our analysis of the Agora burials, and the rich archaeological and textual data for a number of Mycenaean polities. While

specific aspects of the social status hierarchy undoubtedly varied among the polities and over time (as is illustrated by our comparison with the Athenian Agora), these results identify a relationship between social roles and health for Mycenaean elites. Gender differences are another key component of Mycenaean life that had repercussions for health. Our work on oral health differences indicates that the effects of gender constructions crossed the boundaries of the elite social statuses we examined.

Potential explanations for variations in diet include different eating habits for males and females. Females typically spend more time preparing meals and tend to snack and taste food while doing so. Such a pattern of frequent snacking has been linked to higher rates of dental caries (Walker 1988). Of course, we do not know if elite Pylian women were intimately involved in food preparation, so the poor dental health for *tholos* tomb females might require another explanation. The difference in oral health observed between the *tholos* and chamber tombs may also reflect temporal changes in the resource base of Pylos. The issue of temporal differences in the relative consumption of animal protein is difficult to resolve at this stage of our investigations. We are not able to assign individuals to specific time periods when tombs were used for extended periods. However, if larger skeletal samples become available in the future, the comparison of samples from tombs dating to the earlier phases with those from the latter phases of the Mycenaean period could be used to test this idea.

Another factor to consider involves differential participation in feasting or social events where animal protein was consumed. In their most formal manifestations, Mycenaean feasts promoted the prestige of the palace, reified social solidarity, and reinforced the loyalty of the followers (Nakassis 2012). These were performed on a grand scale and would have required up to two tons of meat (Halstead and Isaakidou 2004; Stocker and Davis 2004). Feasts and sacrifices were frequent occurrences in Mycenaean palaces and participation would have been one of the main duties of the ruling individuals (Nakassis 2012; Palaima 2004; Sherratt 2004; Wright 2004b), a fact that might explain the highest $\delta^{15}N$ values for Pylos *tholos* tomb males and higher-status males at other sites.

Differential feasting could also explain why our results for linear enamel hypoplasia do not follow the pattern seen for dental caries and antemortem tooth loss. Hypoplasias are indicative of relatively acute childhood stresses that were apparently experienced by an entire population. In contrast, dental caries and antemortem tooth losses reflect the adult situation for Pylians. Differential adult access to politically important feasts with meat

consumption could explain why dental caries and antemortem losses differ significantly by gender and status while hypoplasia prevalence does not.

Conclusions

This study attests to the powerful analytical potential of research that combines archaeological, skeletal, and bone chemistry data to investigate questions of gender and hierarchy. Examined in isolation, any of these data sources provide some insight regarding social roles for the Mycenaeans of Pylos. However, when they are examined in an integrative fashion, we can see how gender and hierarchy had important effects on the life and health of the population. The hierarchical nature of Mycenaean society, which is evident from their burial practices and texts, was the foundation for differential access to prestige goods, land, and social authority. Embedded within that hierarchy was a system of gender-based inequities that appear to have transcended social strata, resulting in converging patterns of dental health and dietary differences.

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7

Health Status and Burial Status in Early China

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It might seem indisputable that the status of an individual in his or her community can have a significant impact on that person's general well-being, especially in complex societies. Social status is often a significant determinant of access to resources and may therefore be expected to influence such quotidian phenomena as nutrition and the quality of diet. Social status is also likely to influence the degree of involvement in strenuous labor, which in turn defines mechanical stress on the musculoskeletal system, which affects the progression of degenerative joint diseases and the likelihood of traumatic injuries (Bennike et al. 2005; Bielicki and Welon 1982; Brabin and Brabin 1992; Goodman et al. 1987; Reddy 1993). Levels of psychological stress—likewise strongly affected by an individual's standing in their community—can exert a nearly holistic control over human physiology and mediate the functioning of the immune system, thereby shaping an individual's susceptibility to various infectious diseases (Kaplan et al. 1991; Rhen and Cidlowski 2005, 1714; Sapolsky 2004; Sapolsky and Share 1994). Thus, skeletal evidence of deficiency, infectious disease, and traumatic injury may be generally expected to vary in accordance with social status.

Notwithstanding this logic, a plethora of bioarchaeological research on the correspondence between social status and health in the human past has discovered little clear evidence of such simple co-variation (Cucina and İşcan 1997; Knüsel et al. 1997; Palkovich 1984; Powell 1991; Robb et al. 2001; Tung and Del Castillo 2005). Two main reasons for the lack of congruence between status and human health in the past are apparent. First, the relationship between funerary and the social status of a buried individual may be more complex than we realize. While social status has certainly been shown to affect burial construction and influence the selection of associated grave goods, many other factors are also known to bear on those deci-

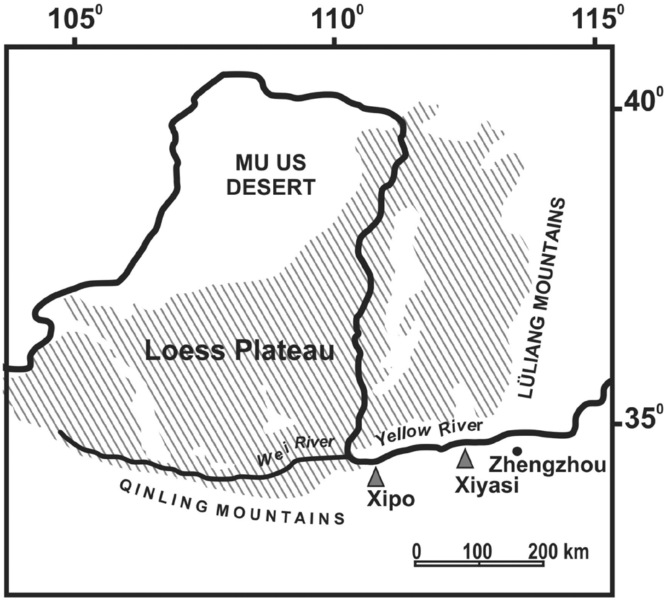


Figure 7.1. Location of Xipo and Xiyasi archaeological sites. Drawing by Kate Pechenkina.

sions, including changes in fashion, competition among the living for both status and control over territory, and the age, sex, number of children, and occupation of the deceased (Binford 1971; Buikstra 1995; Goldstein 1981; O'Shea 1984:36; Saxe 1971). Second, biological stress markers found on the skeleton may sometimes be indirect or circuitous reflections of health status (Robb et al. 2001). Certain life events may have a greater effect on skeletal health than others, while the overwhelming majority of diseases leave no trace on the skeleton at all. Thus, in bioarchaeological research in general—and for the purposes of this study specially—we focus specifically on correspondences between burial status and skeletal health.

In this chapter, we report on the relationship between funerary elaboration and health status based on the examination of skeletal collections recovered at cemeteries dating to two distinct periods in the Chinese past (Fig. 7.1). First, we characterize a skeletal series from Xipo (西坡), a large Middle Neolithic site in Henan Province that is attributed to the Middle/Late phase of Yangshao culture (4000–3000 BC). The material from Xipo is one of the earliest known assemblages from the region for which some form of status differentiation is suggested by an unequal distribution of funerary goods among the burials. Roughly contemporaneous smaller sites

from the same area (e.g., Guanjia) present evidence of minimalist ritual; small objects, such as personal jewelry as burial goods, are only rarely included. Second, we consider skeletal material from the Xiyasi (西亚斯) site, a state-level stratified society dating to the terminal phase of the Bronze Age during the Eastern Zhou dynasty (770–221 BC). We compare evidence of the relationship between burial complexity and health status in early societies with limited regional political hierarchy and little archaeological evidence of status heterogeneity to that pertaining to an early state-level polity in which hereditary social hierarchy was already well established and far more distinct. Through these comparisons, we test whether increasing social inequality and establishment of hereditary political hierarchies led to an increased heterogeneity in the health of local populations from early China.

Methods and Data

Multiple attributes of funerary contexts were used to assess the social status of an individual, including the size of the burial, the complexity of its architecture, the number and type of burial goods, and body orientation. The intrinsic meaning of the funerary context likely changed from the time of early Neolithic communities to the state-level hierarchical society of the terminal Bronze Age. Moreover, the variation in size of the excavated cemeteries and the degree to which the burials were disturbed in some instances necessitated following differing approaches to the analysis of specific funerary assemblages. In order to establish a relationship between different aspects of the funerary context and the social ranking of the deceased, we examined funerary contexts at the two sites independently. Our rationale for specific treatment and status-related grouping of the funerary contexts is detailed in the sections that focus on each time period.

We pursued a multifactorial approach to estimating age at death (Lovejoy et al. 1985a) based on all available skeletal elements. We used age-related morphological changes in pubic symphysis (Meindl et al. 1985; Zhang 1986), auricular surface (Lovejoy et al. 1985b; Buckberry and Chamberlain 2002), medial end of clavicles (Wu et al. 1984), sternal end of ribs (İşcan 1991; İşcan et al. 1984), and maxillary suture obliteration (Mann et al. 1991) to generate an integrative age estimate. Sexual dimorphism is well expressed in adult skeletons from the Central Plain region of China (Wu et al. 1982), allowing us to determine sex of adult skeletons with great confidence. We used Wu and colleagues' (1982) description of sex-related differences in innominate

bones from Han populations as a principal population-specific criterion for identifying the sex of adult skeletons. We also used cranial morphology to evaluate sex (Buikstra and Ubelaker 1994, 20).

Health status was evaluated based on the most commonly reported skeletal parameters and lesions, including long-bone length as a proxy for achieved adult stature, parameters of oral health, and the prevalence of cribra orbitalia and porotic hyperostosis, enamel hypoplasia, degenerative joint disease, and traumatic injuries (Buikstra and Ubelaker 1994; Steckel et al. 2002). When considering the interplay between burial status and indicators of skeletal health, it is useful to maintain a distinction between skeletal parameters that are influenced by morbidity and nutrition status during childhood and skeletal changes that progress with age. Childhood health is reflected by adult long-bone length, enamel hypoplasia, cribra orbitalia, and porotic hyperostosis, as all these parameters are affected by biological stress during childhood. Porotic hyperostosis and cribra orbitalia fall into the category of skeletal markers related to early childhood stress, as these lesions develop in response to bone marrow hyperplasia only during the first few years of an individual's life when the cranial bones still have blood-cell-producing red marrow (Ortner and Putschar 1981; Stuart-Macadam 1987, 1992).

Adult stature was determined based on measured long-bone length, using formulae developed using data on contemporary Chinese populations (for females, Chen 1980; for males, Shao 1985). Because of the fragmentary nature of human remains in the available collections, adult stature could be computed only for a small number of individuals. Porotic hyperostosis and cribra orbitalia were scored following Stuart-Macadam (1985) as excessive porosity with pore coalescence on the bones of cranial vault and orbital roof. Slight microporosity corresponding to Stuart-Macadam's category 1 (Light) was noted but not included in the study, as such porosity may not be related to pathological changes and is often an outcome of normal bone growth. Enamel hypoplasia was recorded following Goodman et al. (1987) on the labial surfaces of anterior teeth.

We examined two groups of skeletal indicators that progress with age and might therefore be affected by an individual's status during adulthood. Oral health parameters, including the distribution of dental carious lesions, antemortem tooth loss, and accretion of calculus, are closely related to food composition, food texture, and the parafunctional use of the teeth. These indicators were scored according to standard procedures. Dental caries were examined with a dental probe and only lesions that admitted the

probe were scored as present. Thus, initial carious discolorations were not included into dental caries count (Lukacs 1989). Calculus accretion was classified as absent, mild, moderate, or severe, according to the protocol of Hillson (1979). To obtain ordinal measures of oral health that could be corrected for age, dental caries prevalence was calculated for each individual as the number of affected teeth divided by number of teeth present. Antemortem tooth loss was calculated as the number of teeth lost per number of dental sockets or tooth positions present. Calculus accretion was quantified as the number of teeth showing accretion times severity score, divided by the number of teeth present.

The progression of degenerative changes on the joint surfaces and the prevalence and distribution of traumatic injury are influenced by the severity and distribution of mechanical stress as related to habitually stressful physical labor, habitual postures, or traumatic injuries. In order to produce ordinal measures of degenerative joint disease, severity-based scores of osteophyte, erosion, and eburnation development (Roberts and Manchester 2005) were scored for both sides of the body and for all individual joint surfaces that form the shoulder, elbow, hip, knee, ankle, foot articulations and all vertebrae. Skeletal fractures were classified as antemortem or perimortem based on the degree of healing. The location and type of fracture was recorded following Lovell (1997). All healed fractures were radiographed in order to further evaluate fracture type and degree of healing.

To control for the varying demographic composition of the different burial subsets, the distribution of these indicators was examined in association with the estimated age at death. We used the midpoint of the estimated age range as a proxy for age at death. For the open age ranges pertaining to older individuals (i.e., 50+ and 60+), the 55-year and 65-year data points were used, respectively. To test the statistical significance of all observed differences, the effect of age was removed by linear regression and the residuals were compared using ANOVA tests.

Results

The Case of Middle Yangshao (Middle Neolithic)

Yangshao (仰韶) was a Middle Neolithic cultural tradition in northern China. From approximately 5000 until 3000 BC, it dominated cultural development across a broad swath of the Central Plain surrounding the middle reaches of the Yellow River. Yangshao material culture is best known

for its black-on-red painted pottery (An 1959; Liu 2004; Ren and Wu 1999; Yan 1989). Yangshao subsistence was based predominately on millet farming and the tending of domesticated pigs, dogs, and probably poultry, but exploitation of wild resources was continued to varying degrees (Ren 1996; Wang 1985; Yan 1992; Yuan and Flad 2002). The Yangshao tradition is typically divided into three phases: Early, or Banpo (4900–4000 BC); Middle, or Miaodigou (4000–3500 BC); and Late, or Xiwang (3500–3000 BC) (Dai 1998; Liu 2004; Zhang and Qiao 1992). Considerable changes in population density and settlement patterns marked the transition from Early to Middle Yangshao (Dai 1998; Ma 2003; Su 1999; Yan 1989). Although fairly little evidence of social inequality is found during the Middle Neolithic, considerable variation among residential sectors and households in terms of activity emphases and resource accumulation is present in Yangshao settlements (Peterson et al. 2010; Peterson and Shelach 2012).

Xipo (西坡), a 40-hectare Middle Yangshao site in western Henan (Fig. 7.1), provides early evidence of the development of social hierarchies in China (Ma et al. 2005, 2006). A three-tier settlement hierarchy among the structures is visible at Xipo, including several large buildings that would have required a substantial investment of labor. The largest of these (F105) measured 516 m^2 and has been interpreted as a gathering place for the whole region that was likely used for ritual activities or other public functions (Ma 2003, 100). An unequal distribution of grave goods among the individuals buried at Xipo probably reflects at least some degree of social stratification (Ma et al. 2005, 2006).

Xipo Mortuary Patterns

Thirty-four burials excavated at Xipo were generally similar in organization. Bodies were placed in a supine position, with the arms alongside of the body and the head facing due west or northwest. In only one case was the head facing south. Single interments were placed in rectangular graves. Burial M11 was unique in that it contained the remains of two individuals: an adult, likely a female, alongside a two- to four-year-old child. Size of the burial cuts varied from slightly larger than minimally sufficient to place the body (e.g., Burial M19's pit was 1.8 m long, and 0.6 m wide) to considerably larger interments with accessory pits for grave goods (such as Burial M27's grave cut, which was 5.03 m long and 3.36 m wide). Since none of analyzed parameters approached normality in their distribution, we used the Kolmogorov-Smirnov test (K-S test) of the equality of continuous, one-dimensional probability distributions of burial area and burial

length. This identified eight burials, each with an area of greater than 8 m^2 and a length in excess of 3 m, as being unusually large. Of these, four burials with an area more than 10 m^2 were clearly size outliers at a 95 percent level of significance.

The number and quality of grave goods varied considerably among the Xipo burials. Six had no grave goods, and the maximum number of items placed into a burial was fourteen (Burial M3). The median number of grave objects was two. A Kolmogorov-Smirnov test suggests that placing more than two objects into a grave could likely be considered as special treatment in some respect. Fifteen of the Xipo burials fit into this category.

The most common burial goods were ceramic vessels of several types, including ritual vessels, such as pear-shaped *hu* (壺) and bowl-shaped *gui* (簋), and utilitarian bowls and cups. Stone objects included axes, scrapers, and a spindle whorl. A spoon, a ring, and a hairpin were among the bone artifacts that were placed in a few burials. Probably of greater symbolic significance were jade objects, including jade axes (*yue*; 鉞), which were found in six burials.

To test whether the area of the burial and the number and the type of grave goods were directly related to the same sociocultural dimensions of the individual's life and death, we performed a number of nonparametric statistical tests. Spearman rank order correlation between the area of the burial and the number of grave goods was relatively high and statistically significant (0.68, 33 *df*, $p = 0.00002$). A Mann-Whitney U test detected a statistically significant difference in the number of grave goods between burials with jade and those without jade objects ($z = -2.49030$, $p = 0.0128$). However, no statistically significant differences in area and linear dimensions were found between burials grouped according the presence or absence of jade objects. Burials were assigned status ranks in each category, based on size (0 = smaller than 8 m^2; 1 = 8 to 10 m^2; 2 = larger than 10 m^2), number of grave goods (0 = no grave goods; 1 = two or fewer objects; 2 = more than two objects), and the presence of jade axes (0 = no *yue*, 1 = jade *yue* present), which altogether summed from 0 to 5. Thus, each burial was classified as Poor (1 or 2), Commoner (2 or 3), or Rich (4 or 5), in accordance with its total score.

Sex, Age at Death, and Burial Status at Xipo

Among the 34 individuals from Xipo available for study, 21 were identified as males, 11were identified as females, and two juveniles were of indeterminate sex. Older adults were very common. Only five of the individuals

Table 7.1. Distribution of sex and age at death among status-score burial groups at Xipo

	Poor	Commoner	Rich	Nonpoor	Totals $N_{individuals}$ (%)
Status score	0–1 $N_{individuals}$ (%)	2–3 $N_{individuals}$ (%)	4–5 $N_{individuals}$ (%)	2–5 $N_{individuals}$ (%)	
Males	14 (82.4)	4 (36.4)	3 (50.0)	7 (41.2)	21 (61.8)
Females	2 (11.8)	7 (63.6)	2 (33.3)	9 (52.9)	11 (32.4)
Indeterminate sex	1 (5.9)	0	1 (16.7)	1 (05.9)	2 (5.9)
Totals	17	11	6	17	34
Age					
< 15	1 (5.9)	0	1 (16.7)	1 (05.9)	2 (5.9)
15–29	1 (5.9)	1 (9.1)	1 (16.7)	2 (11.8)	3 (8.8)
30–45	2 (11.8)	3 (27.3)	1 (16.7)	4 (23.5)	6 (17.6)
45+	13 (76.5)	7 (63.6)	3 (50.0)	10 (58.8)	23 (67.6)
Totals	17	11	6	17	34

had an estimated age at death of less than 30 years. Six apparently died between ages 30 and 45, while 23 had estimated ages at death of older than 45 (Pechenkina 2010).

The sex of the deceased appears to have had some influence on the size of the burial and the number of grave goods (Table 7.1). Most of the female burials (7 of 11) fell into the Commoner category, while male skeletons appear to have been slightly overrepresented in the Poor category (14 of 21). The dual burial of the probable adult female with a young child was among the richest, as it included twelve objects, including three jade *yue* axes. A χ^2 test (7.64, 2 *df*, $p = 0.022$) confirms the significance of the uneven distribution of males and females among the three burial status groups. The median number of grave goods in male burials was one, while in female burials it was a statistically significant six items (Mann-Whitney U: $z = -1.98$, $p = 0.048$). Female graves tended to be larger than those of male individuals, with a median of 6.1 m^2 and 4.9 m^2 respectively. However, a Mann-Whitney U test detected no statistically significant difference between male and female burials in terms of the area of the burial pit ($z = -0.73$, $p = 0.463$).

Female burials also seemed to have received slightly preferential treatment in terms of particular types of grave goods. Only one male burial

contained a jade *yue*, while four of 11 female burials contained jade objects. This was statistically significant ($\chi^2 = 5.46$, 1 *df*, $p = 0.019$). The average number of pots was also higher in female burials than in those of male individuals (3.36 and 2.33, respectively). *Hu* were almost twice as frequent in female burials as in male burials (45.5 percent of females were buried with at least one *hu* pot compared to 23.8 percent of male burials associated with a *hu*). The same was true for *gui*: the average number of *gui* per female burial was 0.90 and the average number was 0.40 for males.

Age at death had little, if any, effect on burial status. The proportions of individuals with different ages at death in the three status-defined burial groups closely corresponded to the overall demography of the Xipo collection, with only minor, statistically insignificant deviations ($\chi^2 = 1.93$, 4 *df*, $p = 0.748$). Spearman rank order correlation between age at death and parameters of the funerary context were low and statistically insignificant ($R = -0.16$, $p = 0.39$). The relationship between age at death and the number of grave goods and area of the burial was also statistically insignificant ($R = 0.06$, $p = 0.72$).

Variation in Childhood Health at Xipo

Small sample sizes resulting from the often fragmentary nature of human skeletal remains were the main impediment to detecting differences related to burial status in the distribution of childhood stress markers. Table 7.2 summarizes the means and frequencies of various skeletal attributes that can be affected by quality of life and morbidity during childhood and adolescence. As seen from this table, none of these attributes exhibit a statistically significant difference among the burial status groups. While males in the Commoner group were much taller on average than those in the Poor and Rich groups (181.7 cm compared to 168.2 cm and 166.4 cm, respectively), the estimated mean for Commoners was based on the heights of only two individuals, one of which happened to be the remains of a very tall individual whose maximum femur length was 512 mm. Thus, this apparent difference in mean stature is driven by a single outlier. Spearman's R correlations between stature and both the number of grave goods and the area of the burial were not statistically significant.

Frequencies of porotic hyperostosis and cribra orbitalia were varied; they were the highest among the Poor, lower among Commoners, and was least common among the Rich burial groups. However, as the frequencies of these markers in the Xipo sample were low overall, these differences did not reach a level of statistical significance. The frequency of enamel hypo-

Table 7.2. Skeletal indicators related to childhood stress at Xipo

						Significance test:	
Burial status	Poor	Commoner	Rich	Nonpoor	Totals	*F*, *p* (*df*)	F, p (*df*)
Stature	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)		
Males	168.2 ±6.14 (12)	181.7 ±15.06 (2)	166.4 ±5.39 (3)	172.52± 8.1	169.4 ±8.10 (17)	3.50, 0.059 (2 *df*)	1.04, 0.325 (1 *df*)
Females	156.2 ±8.79 (2)	153.0 ±12.14 (4)	—	153.0 ±12.14 (4)	154.1 ±10.32(6)	0.10, 0.768 (1 *df*)	0.10, 0.768 (1 *df*)
Skeletal indicator	Freq. (n)	Freq. (n)	Freq. (n)		Freq. (n)	χ^2, *p* (2 *df*)	χ^2, *p* (2 *df*)
Porotic hyperostosis	0.31 (16)	0.22 (9)	0.00 (3)	0.17 (12)	0.25 (28)	1.37, 0.504 (2 *df*)	1.87, 0.171 (2 *df*)
Cribra orbitalia	0.19 (16)	0.11 (9)	0.00 (3)	0.08 (12)	0.14 (28)	0.83, 0.659	0.68, 0.435 (2 *df*)
Enamel hypoplasia	0.13 (15)	0.43 (7)	0.33 (3)	0.40 (10)	0.24 (25)	2.44, 0.295	2.34, 0.126 (2 *df*)

plasia was found to be lower in the Poor group than in the Rich or Commoner burials, again without reaching a level of statistical significance. Frequencies of porotic hyperostosis and cribra orbitalia were fairly similar among all status groups. An ANOVA test using the presence or absence of porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasias as grouping factors, showed no significant association between the presence of these stress markers and the number of grave goods or the area of the burial and.

Indicators of Adult Health at Xipo

Table 7.3 summarizes age-corrected measures of oral health and degenerative joint disease for the Xipo sample. No statistically significant link between oral health indicators and burial status was found. Nevertheless, it is worth mentioning that skeletons from higher-status burials tended to exhibit lower frequencies of carious lesions and antemortem tooth loss than expected for their age (note the negative mean standardized residuals for dental caries and tooth loss). All three oral health indicators showed weak but consistently negative Spearman rank correlations with the size of the burial and the number of grave goods. Only the correlation between calculus and the number of grave goods was statistically significant ($R = -0.38$, 30 *df*, $p = 0.034$).

Individuals from the wealthy burials were characterized by a somewhat lower degree of markers of degenerative joint disease than would be expected for their age, although again, in most cases the differences did not reach a level of statistical significance. On the other hand, differences between the status groups in the degree of development of degenerative changes in the vertebral column were of sufficient magnitude to produce statistically significant results (Table 7.3). These differences were particularly distinct in the thoracic and lumbar segments of the vertebral column. Spearman's R correlations between the number of grave goods and degenerative changes in the thoracic and lumbar areas were statistically significant ($R = -0.41$, 25 *df*, $p = 0.035$; $R = -0.38$, 30 *df*, $p = 0.034$, respectively).

The Xipo skeletal series is characterized by an unusually high prevalence of postcranial fractures combined with a virtual absence of cranial injuries (Pechenkina et al. 2007). The specific suite of postcranial fracture types in evidence included several transverse fractures of the distal ulna (inferred parry injuries), fractures of the metacarpals with volar displacement (boxer-type injuries), and rib fractures (Table 7.4). Such injuries occurred exclusively among male skeletons (47 percent of the 21 male skeletons

Table 7.3. Residual results for age-related skeletal indicators at Xipo

	Mean standardized residual			5 status groups		3 groups	
Indicator	Poor	Commoner	Rich	F (4 *df*)	*p*	F (2 *df*)	*p*
Caries	0.135	-0.255	-0.215	0.561	0.577	1.087	0.391
Antemortem tooth loss	0.16	-0.173	-0.279	0.493	0.616	0.883	0.507
Calculus	-0.101	0.13	-0.199	0.227	0.799	2.059	0.105
All degenerative joint diseases	0.027	0.03	-0.166	0.06	0.94	1.88	0.14
Shoulder/elbow	0.055	-0.191	0.141	0.18	0.834	0.74	0.6
Hip/knee/ankle	-0.095	0.237	-0.116	0.32	0.733	1.54	0.221
Vertebral column	0.206	-0.211	-0.353	1.71	0.201	2.84	0.041

display at least one fracture, whereas none of 12 female skeletons display any fractured postcranial elements). This points toward male engagement in face-to-face interpersonal violence or some kind of combat.

Also, such postcranial fractures appear to have been more common among the skeletons from the Poor burials, where half of all male individuals displayed at least one fracture. The remains of five such male individuals (35.7 percent) displayed multiple injuries. None of the skeletons from burials classified as Commoner and only one from among those classified as Rich had fractured bones. However, as the number of male skeletons in these higher status categories is considerably less (N = 7) than that in burials categorized as Poor burials (N = 14), these differences were not statistically significant ($\chi^2 = 2.52$, 1 *df*, $p = 0.112$).

Table 7.4. Individuals with postcranial fractures at Xipo

Burial status	Poor $N_{individuals}$ (%)	Commoner $N_{individuals}$	Rich $N_{individuals}$ (%)	Among 5 status groups		Among 3 status groups	
Indicator				χ^2 (4 *df*)	*p*	χ^2 (2 *df*)	*p*
With fractures	7 (41.2)	0	3 (60.0)	8.32	0.139	7.82	0.02
Fractures per individual	13 (76.4)	0	3 (60.00)				
N	17	11	5				

To summarize the relationship between burial status and various skeletal indicators in the Middle Yangshao series, it appears that the sex of the deceased individual had the greatest influence on funerary context; females often received a larger number of grave goods and had larger graves. As several juveniles and a number of older adults were buried in fairly large and wealthy graves, age at death does not seem to have played a determining role in burial treatment. No clear relationship between childhood stress markers and burial treatment was found, suggesting that most or all individuals buried at Xipo shared similar nutritional risks and benefits during their childhoods. The association between age-related indicators and burial treatment was weak. Nevertheless, a trend toward less development of degenerative changes than would be expected for a given age in skeletons from the wealthier burials is repeated through multiple independent skeletal/dental indicators. Therefore, we can tentatively infer that social status, as reflected in the specifics of funerary treatment, had some degree of influence on workloads and the quality of available food during adult life in this Middle Neolithic Yangshao community.

The Case of the Eastern Zhou (Terminal Bronze Age)

In 770 BC, during the terminal Bronze Age, the Eastern Zhou succeeded the Western Zhou dynasty when Zhou You (幽), the last of the Western Zhou kings, was killed and the dynastic capital moved to Luoyi (present-day Luoyang), on the northern bank of the Luo River (Di Cosmo 2002, 52). Although the Zhou nominally continued to govern the territory of the Wei and Yellow River basins, the political landscape of Eastern Zhou times was marked by disintegration and rivalry among local rulers (Di Cosmo 2002, 93). A string of localized wars followed, culminating in the Warring States period, when seven powerful regional overlords continuously renegotiated their influence in the Zhou territory. The unification of China in 221 BC under the rule of Qin Shi Huang, who had been king of the Qin state during the late phase of the Warring States period, marked the beginning of the imperial age.

An Eastern Zhou skeletal collection from Xiyasi (an archaeological site in Henan Province), is curated by the Henan Provincial Institute of Cultural Relics and Archaeology. This sample was excavated at Xinzheng (新郑), a satellite city located approximately 40 km south of Zhengzhou, the modern capital of Henan Province. Xiyasi is located outside and near the wall that surrounded the Zheng Han Ancient City (郑韩故城), so named

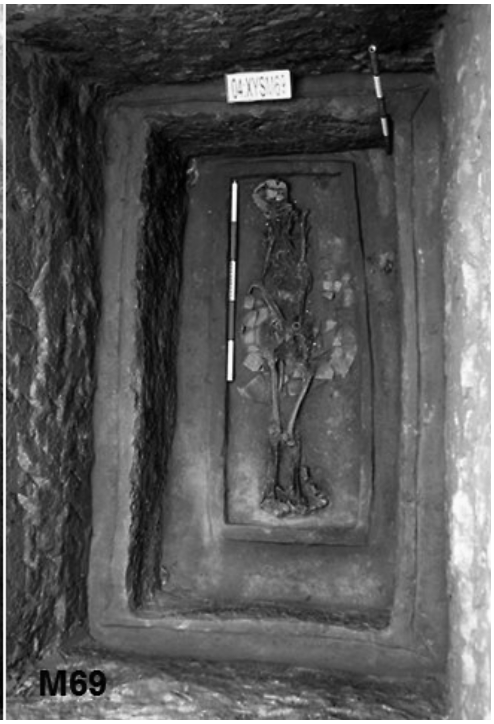
because during different periods of the Chinese Bronze Age it served as the capital of the Zheng State and then of the Han State. Established as the capital of the Zheng kingdom during the late Western Zhou period (1046–771 BC), the city became Han after the Han state overthrew the Zheng ruler in 375 BC.

The cemetery at Xiyasi (Fig. 7.1) is associated with the legendary Yufuzi Burial Mound (渔夫子冢), where an important Han king was buried during the Warring States era. It thus likely had symbolic significance for the populace of Zheng Han during ancient times. Based on the stylistic analysis of associated grave goods, the burials recovered from Xiyasi date to the Spring and Autumn era (春秋时代, 770–476 BC) of the Warring States (战国时代)(475–221 BC) of the Eastern Zhou dynasty (Fan 2012). The proximity of this burial assemblage to the city wall makes it seem likely that the people buried at Xiyasi were inhabitants of ancient Zheng Han.

Xiyasi Mortuary Patterns

Although 350 burials were excavated from the cemetery at Xiyasi, only eighty-five contained human skeletons sufficiently well preserved for analysis. Overall, burial treatment at Xiyasi was standardized: the body was placed into a rectangular grave in a supine position, typically facing north. Because many of the Xiyasi burials were looted, we based our assessment of status primarily on the nature of the burial architecture. Three classes of burials at Xiyasi can be recognized. By far the most common were burials in which the deceased was placed in a simple wooden coffin (i.e., burial M116; Fig. 7.2), often slightly elevated above the ground on small supports placed at each of the four corners so that a ceramic vessel or the body of a small animal could be placed underneath. The furnishings of a more elaborate class of interments included one or more outer coffins surrounding the actual burial container (i.e., Burial M69; Fig. 7.2). A third class of burials, in which the body was placed into a large rectangular chamber with brick walls (Fig. 7.2, Burial M192), appears to have been introduced during the Warring States period. While such labor-intensive tomb structures marked a trend in funerary fashion, the degree of labor investment suggests that those particular deceased individuals were of higher social status than most of their contemporaries.

Although many of the burials encountered at Xiyasi were partially looted, a considerable number of associated grave goods were recovered and provide a second criterion for evaluating the status of the interred individuals. Rare and elaborate grave goods included bronze tripod vessels,



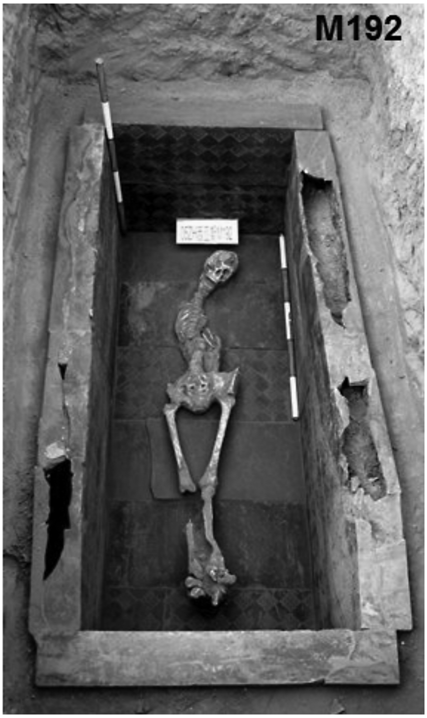


Figure 7.2. Xiyasi burial chambers. M116: burial in a simple wooden coffin; M69: a more elaborate interment that includes an outer coffin encompassing the actual burial container; M192: a Warring State burial in a large rectangular chamber with brick walls. Image courtesy of Fan Wenquan.

lavishly decorated pottery that imitated the bronze vessels, and carved jade ornaments, along with cowrie (*Cypraeidae*) shells and their bronze imitations. Some of the funerary offerings also included smaller bronze objects such as bells and knives and jewelry made of polished quartz. Among the most common grave goods were undecorated pottery, jewelry made of bone beads, and small bone implements.

We grouped the burials being considered into four categories or status levels, based on the complexity of grave architecture and associated funerary objects. The lowest status level, referred to as Poor or Underprivileged, was assigned to burials where the body of the deceased was placed into a single coffin with no grave goods. Burials were placed in this category only when there was no concrete evidence of looting in order to help ensure that grave goods were absent by original intent and not because of a postmortem act of robbery. A total of thirteen burials were assigned to this class. Commoner status was assigned to individuals from burials that were placed in a single coffin and either contained some grave goods or gave evidence of having been previously disturbed, so that grave goods could have been missing due to looting. Some of these burials might properly have belonged to the first category. The Commoner group was the most numerous and includes forty-one burials.

Burials with multilayered construction, (i.e., those that included inner and one or more outer coffins) and those placed into brick-walled enclosures were assigned to an Elite category. Here, we drew a distinction between two inferred elite groups: Elite 1 (N = 4), comprised of elaborate burials that also included high-status grave goods, and Elite 2 (N = 27), which have comparably elaborate construction but do not contain such objects.

Sex, Age at Death, and Burial Status at Xiyasi

Overall, the Xiyasi burial assemblage presents a demographic profile that is not representative of a living population's death assemblage (Table 7.5). There were no young children and very few subadults. Of the individuals whose sex could be identified, males comprised 62 percent of the series and appear to be overrepresented (Pechenkina 2012). Sex and age at death of the deceased appears to have had a strong influence on the amount of investment in a burial structure and its inventory of grave goods. The remains of females were found mainly in lower-status burials and their representation declines as apparent status level increases. All four individuals buried

Table 7.5. Distribution of sex and age at death among status-defined burial groups at Xiyasi

Burial status	Poor N individuals (%)	Commoner N individuals (%)	Elite 2 N individuals (%)	Elite 1 N individuals (%)	Total N individuals (%)
Males	4 (30.8)	25 (61.0)	20 (74.1)	4 (100)	53 (62.4)
Females	7 (53.8)	13 (31.7)	4 (14.8)	0	24 (28.2)
Indeterminate sex	2 (15.4)	3 (7.3)	3 (11.1)	0	8 (9.4)
	13	41	27	4	85
Age					
< 15	0	3 (7.5)	0	0	3 (3.6)
15–29	1 (7.7)	7 (17.5)	3 (11.1)	1 (25)	12 (14.3)
30–45	9 (69.2)	10 (25.0)	4 (14.8)	0	23 (27.4)
45+	3 (23.1)	20 (50.0)	20 (74.1)	3 (75)	46 (54.8)
Totals	13	40	27	4	84

in the Elite 1 tombs were male, and only 14.8 percent of skeletons from Elite 2 burials were identified as females. Among the simple burials with no grave goods, 53.8 percent of the corresponding skeletons were identified as female. A χ^2 test confirms the significant and nonrandom distribution of male and female skeletons among the status-defined burial groups ($\chi^2 = 9.73$, 3 *df*).

Age at death also varied significantly in accord with burial complexity at Xiyasi ($\chi^2 = 16.25$, 6 *df*, $p = 0.012$). The majority of the skeletons assigned to the Poor category were of middle age (30 to 45 years old at death). These individuals likely died before their own children were sufficiently mature to manage the funeral process. Perhaps their burial arrangements were made by others, perhaps by unrelated adult community members. Only 23 percent of the burials in this category belonged to people older than 45. The proportions of older adults in the other status groups were considerably higher: 50.0 percent in the Commoner group, 74.1 percent in the Elite 2 group, and 75 percent in the Elite 1 group. The proportion of young adults (15–29 years old at death) was also higher in burials with funerary goods: 17.5 percent, 11.1 percent, and 25 percent in the Commoner, Elite 2, and Elite 1 categories, respectively, compared to 7.7 percent young adults in the Poor category.

Indicators of Childhood Health at Xiyasi

The frequencies and average values of childhood skeletal health indicators at Xiyasi are summarized in Table 7.6. Because of the fragmentary nature of many of the remains, stature could be estimated for only a small proportion of the individuals. No clear pattern in stature variation between individuals from burial groups with different social status was apparent.

There were no statistically significant differences in the distribution of porotic hyperostosis and cribra orbitalia that was linked to some kind of chronic anemia (Walker et al. 2009; Oxenham and Cavill 2010) between individuals from different burial status groups (Table 7.6). However, this is probably a function of subsample sizes. The crude prevalence of these skeletal markers were considerably greater among remains from the non-elite burials. In the Poor burial group, porotic hyperostosis was evident on the remains of 4 of 10 individuals (40 percent) and cribra orbitalia was evident in two of nine (22 percent). In the Commoner group, the remains of 6 of 37 individuals (15 percent) displayed evidence of porotic hyperostosis and

Table 7.6. Skeletal indicators related to childhood stress at Xiyasi

						Significance test	
						4 groups	elite vs. non-elite
Burial status	Poor	Commoner	Elite 2	Elite 1	Total	F, p (3 *df*)	F, p (1 *df*)
Stature	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)		
Males	173.4 ±4.81 (4)	170.0 ±5.07 (12)	175.3 ±1.46 (6)	172.6 (1)	172.2 ±7.13 (23)	1.09, 0.376	2.408, 0.145
Females	155.9 ±7.35 (2)	153.0 ±3.51 (7)	—	—	153.7 ±4.49 (9)	0.63, 0.457 (1 *df*)	—
Skeletal indicator	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	χ^2, p (3 *df*)	χ^2, p (1 *df*)
Porotic hyperostosis	0.40 (10)	0.16 (37)	0.07 (14)	0.00 (4)	0.16 (65)	5.87, 0.128	2.28, 0.130
Cribra orbitalia	0.22 (9)	0.31 (29)	0.08 (12)	0.00 (2)	0.23 (52)	3.45, 0.328	3.05, 0.080
Enamel hypoplasia	0.36 (11)	0.63 (32)	0.69 (13)	0.75 (4)	0.60 (60)	2.08, 0.555	1.41, 0.235

9 of 29 (31 percent) showed evidence of cribra orbitalia. The frequencies of porotic hyperostosis and cribra orbitalia in the combined non-elite group were 21.3 percent and 28.9 percent, respectively. Only one cranium from the Elite 2 group and none from the Elite 1 group displayed evidence of an anemia-related pathology. Unfortunately, small sample sizes prevent use of tests of statistical significance to further evaluate these observed differences.

Minimal differences in the incidence of enamel hypoplasia were found among individuals from the different status groups. For individuals from the Poor status group, 4 of 11 individuals (36 percent) had at least one hypoplasia defect on anterior teeth. In the Commoner, Elite 2, and Elite 1 groups the frequency of this pathology was higher than in the Poor group, at 63 percent, 69 percent, and 75 percent, respectively, but these differences are not statistically significant. Taken together, these relatively high frequencies of enamel hypoplasia suggest that growth arrest during early childhood was fairly common among the population of Zheng Han.

Indicators of Adult Health at Xiyasi

Unlike skeletal indicators associated with childhood health, some of the pathological changes that progress with age did show statistically significant differences among status groups at Xiyasi, even after the effect of age was removed by linear regression. The number of carious lesions per tooth showed statistically significant differences among the four status groups (f = 5.36, 3 *df*, $p = 0.003$) and when skeletons from all elite burials were pooled and compared with a combined sample comprised of the non-elite burials (f = 5.88, 1 *df*, $p = 0.018$.). Skeletons from the non-elite burials displayed less dental caries than would be expected for their age (note the negative mean standardized residuals), while individuals from the elite burials displayed more dental caries than would be expected (Fig. 7.3).

Other indicators of oral health showed statistically significant differences only when the combined elite group was compared to the pooled non-elite group. As was the case with carious lesions, antemortem tooth loss was more frequent among the individuals from elite burials than expected for their age at death; the rate was lower among non-elite burials. Calculus deposition was more pronounced among elites and less pronounced for non-elites. These differences in oral health between elite and non-elite individuals suggest the likelihood that certain foods were less available to the general populace than they were to wealthier or higher-status individuals. As dental caries development is tightly linked to the availability of dietary

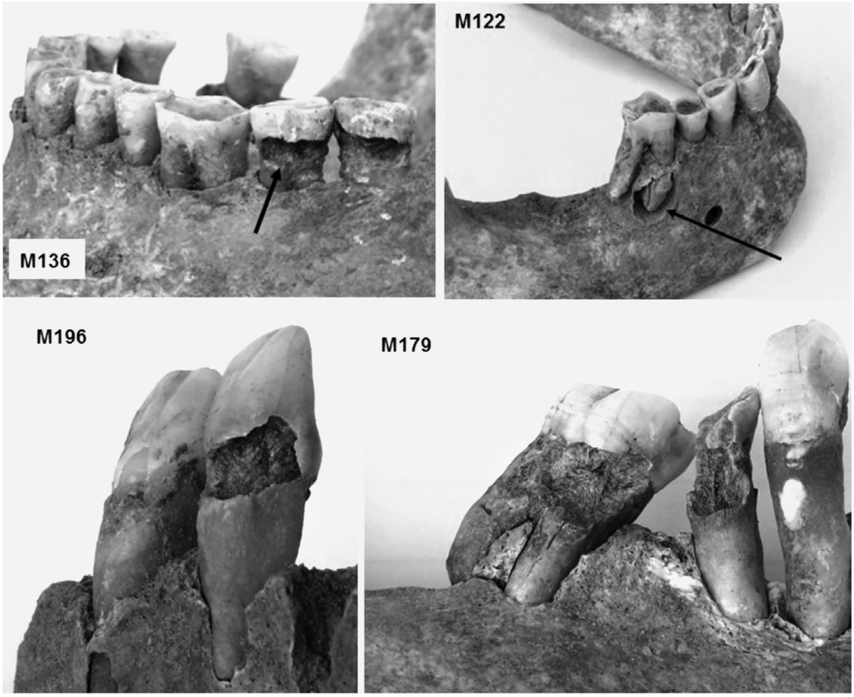


Figure 7.3. Examples of dental caries on dental roots (M136, M196, M179) and a periapical alveolar abscess (M122) in the Xiyasi skeletal series. Image by Kate Pechenkina.

carbohydrates, elite individuals seemed to have consumed an average diet consisting of greater proportions of starches and sugary foods.

The progression of degenerative joint disease (DJD) with age did not differ significantly between individuals from the different status groups (Table 7.7). While the progression of DJD occurred close to the age-based expectation for most status groups, as marked by mean standardized residuals close to zero, there were a few peculiar exceptions. For the Elite 1 group, the development of DJD was less than expected for age at death on all joint systems, but it was especially low for lower limb joints and the vertebral column. In contrast, individuals from the Elite 2 group were characterized by a more pronounced development of DJD, especially among leg and foot articulations. Upon closer examination, it appears that the majority of lower limb DJD in individuals from the Elite 2 group was secondary to minor traumatic injuries of the ankle joints, especially the tibiofibular syndesmosis, the tibiotalar and subtalar joints, and in the metatarsophalangeal joints. Degenerative changes in these joints can develop from stressful

Table 7.7. Residual results for age-related skeletal indicators at Xiyasi

	Mean standardized residual				Among 4 status groups		Elite vs. non-elite	
Indicator	Poor	Commoner	Elite 2	Elite 1	*F* (3 *df*)	*P*	*F* (1 *df*)	*P*
Caries	-0.26	-0.19	0.52	0.10	5.36	0.003	5.88	0.018
Antemortem tooth loss	-0.71	-0.20	0.80	0.71	2.12	0.107	4.07	0.048
Calculus	0.65	0.07	-0.37	-0.38	2.29	0.088	4.47	0.038
All degenerative joint diseases	-0.31	-0.03	0.18	-0.07	0.36	0.781	0.65	0.424
Shoulder/elbow	-0.10	-0.09	0.34	-0.03	1.01	0.399	2.55	0.119
Hip/knee/ankle	-0.03	-0.16	0.53	-1.08	0.73	0.545	0.88	0.355
Vertebral column	-0.06	0.36	-0.67	-1.17	0.52	0.677	1.56	0.229

postural behavior such as habitual squatting with an inverted foot and toes or simply from walking in rugged terrain.

One surprising aspect of the Xiyasyi skeletal collection is the very low frequency of fractures of any kind. Only one skeleton from the Elite 2 group (Burial M220) displayed evidence of healed postcranial fractures. They consisted of a fracture of the fifth metacarpal in a pattern consistent with a pugilistic boxer's injury and a midshaft fracture of the clavicle. This low frequency of fractures in the Xiyasi skeletal assemblage implies infrequent exposure to acute interpersonal violence and a low level of occupational hazard of any type that could lead to bone injuries.

In summary, we would like to emphasize that for the Xiyasi assemblage, sex and age of the deceased seems to have been the most critical determinant of funerary treatment. Males were predominant among the wealthier burials, while average age at death increased in accord with higher burial status. No significant differences in the distribution of childhood stress markers were found, yet a lower frequency of both porotic hyperostosis and cribra orbitalia among the individuals from wealthier burials tentatively suggests that social differentiation affected access to resources, even at an early age. Social status as expressed in funerary contexts appears to have had a strong correlation with cariogenicity of the diet during adulthood,

as individuals from the higher-status burials had statistically higher rates of dental caries, antemortem tooth loss, and calculus accretion. The Xiyasi series as a whole is characterized by a low degree of degenerative joint disease development and a low prevalence of trauma, with no clear association between burial status and the progression of DJD.

Discussion

A funerary ritual is often the final act in a person's life trajectory and can leave behind a snapshot taken through the lens of a particular cultural system and the people who surrounded the deceased. By means of the actions taken on behalf of the deceased by community members, including some who were probably unrelated in a biological sense, the funerary ritual may serve to express in shorthand form the complexities of an individual's life and his or her relationships with others. Some of these relationships are likely to have been constructed before birth, while others will have emerged through the course of a lifetime or even after death. Considering the complexity of the relationships that are distilled into a particular funerary context, the relatively weak associations found between specific skeletal attributes and various parameters pertaining to burial context is not unexpected.

Throughout the known entirety of human prehistory and history, societal roles have been negotiated to varying degrees with reference to the biological attributes that generally serve to assign an individual to a particular gender, whether it corresponds to binary notions of biological sex or not. Finding a correspondence between particular assemblages of grave goods and the sex of the associated individual as determined from skeletal or mummified remains is commonplace in anthropological research (e.g., Arriaza et al. 2008, 50; Binford 1971, 20; Hamlin 2001, 131; Lucy 1998, 32–34; Pechenkina and Delgado 2006; Snortland 1994, 63; Stoodley 1999, 29). In this study, strong and statistically significant associations were found between skeletally determined sex and aspects of funerary patterns from both the Middle Neolithic and Eastern Zhou.

Many prior archaeological studies have found significant correspondence between sex and specific types of associated material culture (e.g., Arriaza et al. 2008, 50; Hamlin 2001, 131), leading to the designation of certain grave goods as gender specific. In the present study, we discerned a more general association between the sex of the deceased and burial complexity. The differing relationship between sex and burial wealth in the two

societies we considered mirrors considerable differences in gender-related social roles that developed between the time of Middle Yangshao and the time of Eastern Zhou. In the Eastern Zhou, a greater proportion of male burials fell into the wealthier category, and those individuals tended to live longer. This information corresponds well with our context-based expectation of a patriarchal society. However, the relationship between sex and burial wealth at Xipo was more complex. The wealthiest burial excavated there was a dual interment of a female and a child, while the next richest was that of an adult male individual. Overall, a substantial proportion of the Xipo males were buried entirely without grave goods. This phenomenon resulted in Late Neolithic female burials that were wealthier on average than those of males.

Chinese archaeology from the 1960s–1980s was influenced by Marxist social theory and concepts of social evolution stemming from the work of Friedrich Engels (1884), which tended to envision Neolithic societies as egalitarian and organized around matrilineal clans (Gao and Lee 1993, 268). Wealthy female burials dated to various phases of the Neolithic were cited in support of a suggested prominent role for females in the pertinent early Chinese societies (Banpo Museum 1975; Wu 1961). However, in more recent times, this putative relationship between sex and burial wealth during the Neolithic has been less emphasized.

In the case of the Xipo assemblage, equating positive correspondence between sex and burial wealth with a specific form of social organization would seem to be a gross oversimplification. There is little, if any, skeletal evidence to suggest that females enjoyed a privileged position in the ancient Xipo community. Sexual dimorphism in stature is fairly pronounced in the Xipo series (Pechenkina et al. 2007, 2013). Stable isotope analysis of human bone collagen samples from Xipo (Gong 2007) indicates that males had a considerably greater proportion of animal products in their diet than females. The considerably higher rates of dental caries and other carbohydrate-driven pathologies among females imply that women's diets were largely based on millet. Overall, similar rates of bone lesions were found for males and females in the skeletal collection from Xipo, as has also been the case for collections from other Middle Neolithic sites on the Central Plain of China. Thus, the apparently privileged status accorded to females in death did not correspond with better health status during life.

A number of previous bioarchaeological studies reported more distinct correspondences between burial status and skeletal and dental health markers that progress during adulthood (Klaus et al. 2010; Cucina and

Tiesler 2003; Jankauskas 2003; Robb et al. 2001; Rodrigues 2004; Sakashita et al. 1997) than with those that reflect childhood health (Cucina and İşcan 1997; Robb et al. 2001; Tung and Del Castillo 2005). Likewise, we observed statistically significant correspondences between burial status and a number of age-related markers. In the Xipo case, these markers were related to activities, including the development of osteoarthritis in the vertebral column and postcranial traumatic injuries. These tended to show less progression than would be expected for age at death among individuals from burials with higher status, whereas all other diet- and activity-related indicators failed to yield statistically significant differences between burial status groups. Thus, it seems that achieving a certain status in life made possible a decrease in habitually strenuous activities and commensurately fewer risks of injury, even during the Chinese Middle Neolithic.

In the Eastern Zhou setting at Xiyasi, in contrast to what we found at Xipo, frequencies of oral pathological conditions related to food consistency and texture were quite distinct between burial status groups. These indicators were also more pathologically advanced than expected for age at death among individuals from wealthier Xiyasi burials. The initiation of dental caries infection involves consumption of sucrose by endogenous acidogenic *Streptococcus mutans*, *Lactobacillus acidophilus*, and related bacteria on tooth surfaces (Cury et al. 2000) and further progression requires water-soluble carbohydrates. Therefore, we can suggest that individuals whose remains were recovered from the wealthier burials at Xiyasi were able to indulge in the consumption of foods with higher sugar content than what was available to their poorer contemporaries. Furthermore, as the same individuals display a greater accumulation of dental calculus, which can be removed by edibles with an abrasive texture, individuals in wealthier burials likely had greater access to highly processed, softer foodstuffs. Such differences in oral pathology between people from the different status groups imply considerable differences in average dietary patterns between elite and commoners.

Although not statistically significant, a clear trend toward lower frequencies of porotic hyperostosis and cribra orbitalia in the higher-status burial groups implies that individuals of differing status in Eastern Zhou society were subjected to different degrees of anemic stress in childhood. The magnitude of those differences in the prevalence of anemia indicators between individuals from the elite and non-elite groups is somewhat surprising. While a diet poor in heme-bound iron increases the likelihood of anemia in children, the results of some recent bioarchaeological studies

have led to a suggestion that megalobastic and hemolytic anemia, poor hygiene, contaminated drinking water, and consequent intestinal infections resulting in prolonged diarrhea was an important factor in shaping patterns of this pathology in prehistory (Klaus and Tam 2009; Blom et al. 2005; Wright and Chew 1999). Thus, the finding of even a weak correspondence between burial status and the prevalence of anemia in the sample from Xiyasi tentatively suggests that status differences apparently mediated differential access to resources and exposure to parasites during childhood.

The lack of any statistically significant correspondence between the progression of degenerative joint disease and burial status among the people buried at Xiyasi is likely to have been a consequence of the urban nature of this population, which probably included craftspeople and merchants but few, if any, people engaged in agricultural activities. Indeed, the virtual absence of postcranial trauma and the slow progression of DJD suggests that this group generally did not engage in physically demanding labor or physical confrontations.

Conclusions

In this chapter, we examined the relationship between burial status and skeletal markers of sex, age, and health in two temporally distinct skeletal collections from China's Central Plain: the Middle Yangshao Xipo series and the Eastern Zhou Xiyasi series. In both cases, the sex of the deceased had its strongest association with burial wealth, although the direction of this relationship was inverted between the two cases. In the Neolithic series, female burials on average had a richer inventory and greater size, while the majority of male burials had minimal or no grave goods. In the Eastern Zhou case, the proportion of male skeletons in each subset increased with an increase in burial rank. Age at death was a significant factor in determining burial status for the Eastern Zhou but was not clearly related to funerary context in the Neolithic Yangshao case.

Aside from indicators of skeletal sex, skeletal markers of adult health showed a more direct association with burial status than attributes that develop during childhood. In comparing the two cases, such relationships were found to be somewhat distinct from one another, likely owing to the different physical demands and dietary opportunities presented to people in each of the time periods. The Xipo collection, which is likely representative of Neolithic farmers, reflected a significant association between burial status, DJD, and rates of traumatic injury. In the Xiyasi collection, which

probably represents urban dwellers at Zheng Han, higher-status burials were associated with significantly greater frequencies of dental caries, calculus accretion, and antemortem tooth loss. A clear association, albeit statistically insignificant, between burial status and the skeletal stigmata of childhood anemia tentatively suggests that in the city of Zheng Han, social status differences began affecting human health early in life and that these differences generally persisted through maturation and into adulthood.

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III

Skeletons in Settings of Emergent Complexity and Stratified Societies

8

The Bioarchaeology of Early Social Complexity in Bronze Age Spain

Skeletal Biology and Mortuary Patterns in the El Argar Culture

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The Bronze Age in Europe is generally characterized by sociopolitical formations in which status and power were extremely important elements of society (Chapman 2003; Harding 2000). All of these groups were characterized by the emergence of elites, a high level of political centralization, the competitive exchange of goods and ideas, marked social differentiation, and concepts of leadership within a hierarchical society (Guilaine and Zammit 2002). The social dynamics of this period also included attributed social status, hereditary privileges, and power disparities. One of the most important cultures in the Western Mediterranean area was the El Argar culture, which extended throughout the southeastern Iberian Peninsula and was first identified in the late nineteenth century through archaeological excavations by the Siret brothers (Siret and Siret 1890). This culture is characterized by many complex developments; for example, there are records of an evident increase in social inequality from the Copper Age onward (Chapman 2008). This change is manifested in funerary patterns, which show a shift from collective burials in which the bodies received equal treatment to individual burials marked by pronounced variation in funerary structures and grave goods. The objective of this study is to determine whether there is an association between increasing social complexity and the presence of certain signs of disease in skeletons from individuals of El Argar culture. The aim is to explore whether social differences denoted by mortuary organization and the quality of grave goods may also be reflected in the skeletal biology of the people found at these sites.

The El Argar Culture

The El Argar culture, which existed from 2200 to 1450 BC (Molina and Cámara 2004) in the southeast region of the Iberian Peninsula, is one of the most important phenomena of the Bronze Age in Western Europe. Populations lived in small villages on steep mountains and hills that dominated fertile valleys and were located near mineral resources. El Argar settlements usually featured a walled acropolis at the highest point surrounded by dwellings on stepped terraces. Their economy was based on livestock herding, agriculture, and mining (Molina and Cámara 2004).

El Argar tombs were usually single or double internments situated below dwellings. Bodies were placed in a flexed position. Grave goods differed according to the sex of the individuals and varied in number and quality. Items included with the dead were stone, bone, and metal ornaments and different types of pottery, metal axes, swords, daggers, halberds, awls, and pins (Lull 1983). Metal objects have been previously associated with an intermediate to high social level. Thus, swords and halberds are inferred as prestige goods typical of warriors, while the metal used for ornaments (bronze, silver, or gold) indicates the social rank of the deceased (cf. Klaus, Shimada et al., this volume). The presence of food offerings such as legs of bovids and ovicaprids appear to indicate that practices of ritual feasting were a component of El Argar mortuary rites (Aranda and Esquivel 2006).

Past work by Cámara and Molina (2006) indicated that El Argar society was involved in a process of consolidating and amplifying social hierarchies. This is especially evident in the articulation between walled settlements and their physical settings, the internal settlement organization, differential consumption patterns of certain products among dwellings, the standardization of portable items of material culture, and differences in the characteristics of tombs and funerary goods. It is common to find sectors with rich tombs and high-status and high-quality funeral goods, generally within walled areas. These are considered to have belonged to the dominant elites. They are often situated closer to public places than are the graves of individuals who are inferred to have been poor, which are found below dwellings in the peripheral areas. In some settlements where individuals of inferred differing social status associated with the same dwelling have been interred together, this has been considered to be burials of nobles with their servants (Cámara and Molina 2006).

The inference of class differences from domestic and funerary findings prompted the description of the Argaric culture as an early state society

(Chapman 2008). The spatial organization of burials, sex-based differentiation in funerary goods, and activity patterns discerned from human skeletal remains (Jiménez-Brobeil et al. 2004) indicate a society based on a nuclear family structure and a strong separation between gender roles and activities. Family structures have been deduced from the layout of adult and child burials situated below each dwelling. The physical features of some skeletons, such as their dental morphological traits, indicate possible close biological kinship. Double burials containing a male and a female skeleton were usually buried at different times (Cámara and Molina 2006; Lull 1983). A tomb would be built when one member of the couple died. Upon the death of the other member, the burial would be opened, the bones and objects previously placed there would be moved aside, and the new body would be placed inside. Also, weapons appear in male burials and domestic items appear in female graves (Molina and Cámara 2004).

Materials and Methods

The Site of Cerro de la Encina (Monachil, Granada)

The Cerro de la Encina in Monachil in the province of Granada is an important site of the El Argar culture. Although only a small number of skeletons have been discovered, it was selected for the present study because the corresponding archaeological contexts reveal a clear and consistent differentiation in the value of funerary goods and a complete analysis of the human remains is available. This allows for an initial test of various hypotheses regarding El Argar social organization using a bioarcheological approach.

The Cerro de la Encina is located in the foothills of the Sierra Nevada near the Monachil River, overseeing a wide area of the fertile lowlands (*vega*) of Granada. The settlement occupied the stepped terraces of a steep hill that has a small fort on its summit. Horse breeding was an important economic activity and may have carried a certain social prestige (Aranda and Molina 2005, 2006; Molina 1983). In accordance with the classical Argaric pattern, the central features of mortuary structures included: 1) shafts containing artificial caves cut into the rock and closed with masonry walls or flagstones; 2) cists (i.e., rectangular boxes made of stone slabs); and 3) simple earthen pits, with or without stone covers. The radiocarbon (^{14}C) dating of nine burials range from 1950 ± 60 BC to 1420 ± 20 BC (calibrated dates, University of Groningen Laboratories) (Aranda and Molina 2006). Tombs

were distributed in groups comparable to settlement "neighborhoods." One group of tombs was characterized by complex architectural structures and by the largest number and highest quality of burial goods, while another group had very simple structures with scant or no grave offerings (Aranda and Molina 2005; Aranda et al. 2008). This pattern of diversity in funerary arrangements suggests the possibility of a social structure that is expressed in urban spaces with a clear social-spatial bias in which differential access to the means of production appears to be meaningfully reflected in the organization and types of tombs and in the different quality of funerary goods (Aranda and Molina 2005). Further, the presence of infant burials with very rich goods (gold ornaments) indicates that social status was assigned from birth (Molina 1983). This finding is of interest, because no grave goods have been found in the burials of small children at other Argaric sites.

Although the first anthropological studies of human remains from Cerro de la Encina commenced in 1922, the present study includes only the 31 skeletons retrieved by excavations in the 1970s and 1980s and from 2003 to 2005 (Al Oumaoui and Jiménez-Brobeil 2005; Aranda et al. 2008; Jiménez-Brobeil and García Sánchez 1989–1990).

Analytical Methods

The sex and age of the individuals were estimated using standard protocols (Byers 2002; Ferembach et al. 1979; İşcan 1989; Scheuer and Black 2000; Ubelaker 1989). Life tables were calculated according to Acsadi and Nemeskeri (1970), and adult stature was estimated by using the formulae of Pearson, Trotter-Gleser (Olivier 1960), and Mendonça (2000). For the study of health and disease, we recorded specific skeletal stress markers, including enamel hypoplasias, cribra orbitalia, porotic hyperostosis, nonspecific periostitis, and signs of maxillodental disease such as dental caries, antemortem tooth loss, and periodontal disease. Dental caries and antemortem tooth loss were recorded by tooth count, while periodontal disease was documented by individual count. Enamel hypoplasia (Goodman and Rose 1995) reflects episodic growth disruption caused by relatively acute metabolic stress during childhood. Cribra orbitalia and porotic hyperostosis (Ortner 2003) are related to ferropenic anemia, megaloblastic anemia, deficiencies in vitamins B_9 and B_{12} arising from complex synergisms among inadequate diets, diarrheal diseases, and intestinal parasites (Walker et al. 2009). Nonspecific periostitis can indicate chronic infectious diseases or venous stasis, among other conditions (Aufderheide and Rodríguez 1998; Ortner 2003). Activity patterns were estimated according to the

presence of degenerative disease such as osteoarthritis, vertebral disc pathology, skeletal traumatic injuries, and the presence of entheseal changes (Al Oumaoui et al. 2004). Although osteoarthritis, which is characterized by lipping, eburnation, and porosity on the surface joints, has a multifactorial etiology (Rogers and Waldron 1995; Weiss and Jurmain 2007), its progression can be influenced by intense physical activity (Brandt 2003). The risk of traumatic injury can also be increased by intense physical activity (Jiménez-Brobeil et al. 2009; Koval and Zuckerman 2002). Entheseal changes can further provide information about muscle development (Villotte et al. 2010).

Results

We report here only the essential data for the objectives of this study. Extensive details regarding the burials and bioarchaeological data are published elsewhere (Al Oumaoui and Jiménez-Brobeil 2005; Aranda and Esquivel 2006; Aranda and Molina 2005; Aranda et al. 2008; Jiménez-Brobeil and García Sánchez 1989–1990).

The graves discovered at Cerro de la Encina are located in two different areas at the site, (see Table 8.1). The first (Area A) includes burials 6, 7, 8, 9, 10, 11, 12, 13, 18 19, 21, and 22, which all contain rich funerary goods.

Area A

This area consists of a group of tombs placed below dwellings in the central part of the site.

Burial 6 was an artificial cave context with a funerary offering consisting of a copper awl and three pottery objects. It could be considered to be of intermediate to high social status. It held the remains of a woman 30–40 years old. Her remains showed no evidence of musculoskeletal stress markers or signs of disease. It also contained a child in the fourth year of life, probably male according to the morphology of the mandible and iliac bone (Schutkowski 1993), whose remains also demonstrated no markers of biological stress.

Burial 7 was a pit burial with no funerary goods containing the skeleton of a 6- to 12-month old child with no pathological abnormalities. Burial 8 was also a pit burial, but it contained highly elaborate funerary goods, including a gold bracelet, a copper dagger with silver pieces, and a pottery vessel. It contained the remains of a 3- to 4-year-old child with no skeletal pathological conditions.

Table 8.1. Burial data and skeletal pathological conditions observed in the individuals from Cerro de la Encina

Area	Burial #	Estimated sex	Estimated age	Complexity of funerary goods	Skeletal trauma	Degenerative joint disease	Musculoskeletal stress markers	Enamel hypoplasia	Porotic hyperostosis/ cribra orbitalia
A	6	female	30–40	medium-rich	absent	absent	absent	absent	absent
A	6	?	4	medium-rich	absent	—	—	absent	absent
A	7	?	6–12 months	unknown	absent	—	—	absent	absent
A	8	?	3–4	very rich	absent	—	—	absent	absent
A	9	male	30–35	very rich	absent	absent	moderate	absent	absent
A	10	male	21–40	rich	absent	absent	moderate	—	absent
A	10	female	adult	rich	—	—	—	absent	—
A	10	?	2.5–3	rich	—	—	—	absent	—
A	11	male	41–60	rich	absent	osteoarthritis	absent	absent	present
A	11	female	20–25	rich	absent	absent	absent	absent	absent
A	12	male	25–27	very rich	absent	absent	absent	absent	absent
A	12	?	13–15	very rich	absent	absent	absent	—	absent
A	13	female	50–60	rich	absent	absent	absent	absent	absent
A	18	male	30–40	rich	absent	absent	moderate	absent	absent
A	18	female	25–35	rich	absent	absent	moderate	absent	absent
A	18	female	40–45	rich	absent	absent	moderate	absent	absent

A	19	male?	9–10	unknown	absent	—	—	present	absent
A	20	male	30–35	rich	absent	osteoarthritis	strong	absent	present
A	20	female	30–50	rich	present	osteoarthritis	strong	present	present
A	20	male?	3–3.5	rich	absent	—	—	present	—
A	20	male?	9	rich	absent	absent		present	-
A	21	male	22–24	very rich	absent	absent	absent	present	absent
A	21	female	16–17	very rich	absent	absent	absent	absent	absent
A	22	male?	3	rich	absent	—	—	absent	absent
A	22	female?	2	rich	absent	—	—	absent	absent
B	14	male	35–39	poor	present	osteoarthritis	strong	absent	absent
B	14	female	40–50	poor	present	osteoarthritis, Schmorl's depressions	moderate	absent	absent
B	15	male	40–49	unknown	absent	Osteoarthritis, Schmorl's depressions	strong	present	absent
B	16	male	40–50	unknown	absent	osteoarthritis	moderate	absent	present
B	16	female	50–60	unknown	absent	absent	moderate	present	absent

Note: — = unobservable; no data.

Burial 9 (Fig. 8.1) was a cist burial with very rich funerary goods, including two gold earrings, a copper dagger, four pottery objects, and a bovid meat (leg) offering. It contained the skeleton of a 30- to 35-year-old male with moderate entheseal changes and no pathological abnormalities.

Burial 10 was an artificial cave with rich funerary offerings that included nine metal objects (silver, bronze, and copper), and twelve ceramic objects. The skeletons were very poorly preserved. Nevertheless, it was clear the burial contained a 21- to 40-year-old male with moderate entheseal changes and no pathological abnormalities and the remains of an adult female and fragments of a 2.5- to 3.0-year-old child.

Burial 11 was a second artificial cave with an imposing but poorly preserved architectural structure and rich funerary goods that included a silver bracelet, a copper knife, a bone awl, a stone ornament, and a ceramic object. It contained the remains of an older adult male and a 20- to 25-year-old female. There were no musculoskeletal stress markers, although the male was affected by porotic hyperostosis and mild osteoarthritis in the vertebral column. The latter lesions were likely related to his age. Burial 12 was a third artificial cave with large architectural structure and very rich funerary goods that included two silver ornaments, a bone ornament, stone beads, and five ceramic vessels. It contained the poorly preserved remains of a 25- to 27-year-old male and a young 13- to 15-year-old individual of unknown sex. There were no musculoskeletal stress markers or pathological abnormalities.

Burial 13 was a fourth artificial cave with rich goods that included two copper objects, a bone ornament, two pottery objects, and a bovid meat offering. It contained the skeleton of a 50- to 60-year-old female with no signs of musculoskeletal stress markers, degenerative joint disease, or other skeletal stress markers. Burial 18 was documented in the fifth artificial cave, which contained a rich assemblage of funerary goods that included four metal objects, stone beads, four ceramic items, and a bovid meat offering. It contained the remains of a 30- to 40-year-old male, a 25- to 35-year-old female, and a 40- to 45-year-old female. The male and the females were all characterized by moderate entheseal development. There were no pathological lesions in these three skeletons.

Burial 19 was a pit burial with no grave goods, although its material contents may have once been present and then lost due to erosion. It was spatially in the same funerary cluster as the burials with rich goods, very close to Burial 18. It contained the remains of a 9- to 10-year-old child who

Figure 8.1. Cerro de la Encina Burial 9. This mortuary context is a representative example of the graves characterized by "rich" funerary goods. Photo by Department of Prehistory and Archaeology. University of Granada.

was possibly male according to the mandibular morphology and was affected by enamel hypoplasias in the permanent canines.

Burial 20 was located in the sixth artificial cave, which had a rich assemblage of funerary goods that included five metal objects, stone beads, and five ceramics. The mixed and poorly preserved remains of four individuals were found, including a 30- to 35-year-old male with significant entheseal development, mild osteoarthritis in the lumbar spine, and cribra orbitalia. A 30- to 50-year-old female had significant entheseal hypertrophy in the upper limbs (especially the hands), mild osteoarthritis in knees, a possible ligamentous lesion in the right knee, cribra orbitalia, enamel hypoplasia, and bilateral tibial periostitis. A 3.0- to 3.5-year-old child (possibly male according to the mandibular and iliac morphology) was affected by mild enamel hypoplasia and growth retardation as detected from the mismatch between the age estimated from his height and the age indicated by his dental development. A 9-year-old child was also present, and was also probably male according to iliac morphology. This individual had bands of enamel hypoplasia corresponding to multiple stress episodes.

Burial 21, the seventh artificial cave, was comparatively large. It had an impressive architectural structure and the richest sample of funerary offerings at the site, which included six silver items, eight copper objects, stone beads, a stone archer's bracelet, seven ceramic vessels, and three butchered bovid legs (meat offerings). It contained the skeletons of two individuals buried simultaneously. One was a 22- to 24-year-old male who had no musculoskeletal stress markers but did have enamel hypoplasias. The other individual was a 16- to 17-year-old female showing no musculoskeletal markers or any other pathological abnormalities.

Burial 22 was a cist with rich funerary offerings, including a stone bead necklace and three ceramic items. It contained the bones of a 3-year-old child (probably male) and a 2-year-old child (probably female). The boy was small for his age, as estimated from a comparison of long-bone length (Scheuer and Black 2000) to the age indicated by his dental development (Ubelaker 1989). Neither infant showed pathological abnormalities.

Area B

A second group of tombs (Area B) was some 50 meters away from Area A. It included Burials 14, 15, and 16, which contain either grave goods of poor quality or none at all.

Burial 14 was an artificial cave with low-quality funerary offerings, including a pottery vessel and an ovicaprid meat (leg) offering. It contained

Figure 8.2. Cerro de la Encina, Burial 15. This individual's interment is a representative example of the graves characterized by "poor" or absent funerary goods. Photo by Department of Prehistory and Archaeology. University of Granada.

a 35- to 39-year-old male and a 40- to 50-year-old female. The male had marked entheseal changes consistent with very well-developed musculature, degenerative joint disease in the vertebral column, and healed fractures of both the nasal bones and several ribs. The female's skeleton showed moderate entheseal development, vertebral compression fractures, several Schmorl's depressions, and osteoarthritis in the spine, wrists, and hands.

Burial 15 (Fig. 8.2) was a pit burial with no funerary goods. It contained the remains of a 40- to 49-year-old male individual with entheseal changes consistent with extensive muscle development, Schmorl's depressions in some thoracic vertebrae, osteoarthritis in the spine, and periostitis of the tibiae. Burial 16 was another pit burial and contained no funerary goods. It contained a 40- to 50-year-old male and a 50- to 60-year-old female. Entheseal changes suggested the male had moderate muscle development, porotic hyperostosis, and mild osteoarthritis in knees. The female's bones had mild entheseal changes and enamel hypoplasia but no degenerative joint disease.

Discussion

A small sample size is frequently the Achilles' heel of bioarchaeological research. In this case, the small sample inhibits extensive statistical evaluation of the mortuary and skeletal patterns observed in these remains from Cerro de la Encina. Nevertheless, an exploratory context-based analysis points to evidence of a clear differentiation in the value of funerary goods, with a tendency for "rich" burial goods to be associated with skeletal remains with few or no pathological lesions or musculoskeletal stress markers. The state of health and activity patterns of the individuals permits their division into two groups that coincide with the clustering of mortuary spaces and the quality of funerary goods. Only Burial 20 was inconsistent with this pattern; the privileged location and value of the goods contrasted with the state of health of the individuals in the tomb. Skeletal stress markers in the adults indicate a long history of intense physical activity. Their remains show signs of morbidity that are also observed in the two children from the same tomb. Based on current archaeological knowledge of the Argaric world, one possible explanation is that these individuals were servants of an elite family under whose dwelling they were buried. It is possible that the master of the house took responsibility for the funerary offerings (Cámara and Molina 2006). However, we emphasize that our interpretations of the findings in this burial cannot be confirmed and remain speculative.

Unfortunately, it was possible to estimate the terminal adult stature of only eight individuals. The average height of males in tombs with rich goods was 173.6 cm, and the averages ranged between 167.2 and 184.2 cm. Among the males in poorly endowed burials, the average adult stature was 166.79 cm; the range was 164.5–166.9 cm. However, the small sample size renders this relationship tentative; it needs to be verified in studies with larger samples.

No differences in oral health were found between the individuals in rich and poor tombs (Al Oumaoui and Jiménez-Brobeil 2005), who expressed a similar frequency of dental caries and antemortem tooth loss. The intense molar wear common to all individuals indicates a hard diet or a food preparation system that introduced abrasive particles into foods (e.g., the stone milling of grain). The latter possibility is supported by the discovery at the Cerro de la Encina of various millstones in a boat shape that is attributed to heavy use (Molina 1983). These dental findings suggest that the diet (carbohydrate intake) and manner of food preparation did not differ significantly among the social classes.

Canines were preserved in 27 individuals, and six of these showed evidence of bilateral enamel hypoplasias of canines. Four inferred lower-status individuals were affected compared to two inferred higher-status individuals; together they generated a crude prevalence of 22.2 percent for the entire sample. This percentage is considerably lower than the 50.6 percent reported in other Argaric populations (Jiménez Brobeil n.d.), which may indicate overall superior childhood health in this Monachil population. Although we cannot draw reliable conclusions from these limited data, these findings represent the starting point for new hypotheses about the El Agar culture. Cranial vaults were observable from twenty-five individuals and orbital roofs from seventeen individuals, allowing evaluation of the presence of porotic hyperostosis and cribra orbitalia, respectively. Three individuals (one higher-status and two lower-status) show a widening of the diploë, while another three individuals (one higher-status and two lower-status) reveal evidence of cribra orbitalia. Only two of the twenty-seven individuals showed signs of periostitis, and both of them appeared to be from lower social strata.

Although the limited number of individuals studied prevents the drawing of broad conclusions, some consistent patterns can be discerned from the data. There appears to have been a tendency for a lower presence of musculoskeletal stress markers, trauma, and degenerative disease in the higher-status subjects. However, these indicators have a multifactorial origin, and it should be borne in mind that having high social status might imply superior health but not universally effective buffering against infectious or parasitic diseases.

Given that social status appears to have been assigned from birth in this Bronze Age society (Molina 1983), more health problems could be expected in individuals from poorer than in individuals from richer tombs, based on the results of modern epidemiological studies on health outcomes and socioeconomic inequality. Once more, however, we are unable to confirm this association because of the small sample size. At any rate, although there would likely have been dietary differences in children from higher- and lower-class parents, both would have been exposed to similar environmental conditions and would have been more susceptible to infections than the adults. A study of larger skeletal samples assessed alongside multiple lines of archaeological context is warranted in order to explore the presence of growth retardation in children and to examine any features attributable to physical activity and the age at which habitually strenuous activities may have started.

The fact that only a few adult individuals had relatively complete long bones and intact joint surfaces also hampered activity pattern analysis. In general, our study confirms the well-known progressive relationship between degenerative joint disease and age. However, we highlight its presence in two individuals under the age of 40 from poor tombs (Tombs 14 and 20) and its absence in two mature women from high-status tombs (Tombs 13 and 18). We also observed a general association between joint lesions and musculoskeletal stress markers. Osteoarthritis affected older males from Tombs 11, 14, 15, 16, and 20, and distinct musculoskeletal stress markers affected individuals in Tombs 14, 15, and 20. The only females with signs of osteoarthritis were a mature female from Tomb 14 and an adult female from Tomb 20. Osteoarthritis may simply correlate to the age of the males in Tombs 11 and 16 but could be the result of more intense physical activity occurring earlier in life and among those under 40 years old in Tombs 14 and 20.

Conclusions

Bioarchaeological data obtained from the Cerro de la Encina mortuary sample are tentatively consistent with archaeological information on Argaric society. From an anthropological standpoint and considering only the information yielded by the bones, one group of individuals appears to have engaged in intense physical activity and showed more signs of various forms of biological stress. They can be contrasted with another group that lacked similar patterns of morbidity and whose skeletal health appears to have been relatively good. The fact that the former group tended to have poor funerary goods and the latter very rich goods suggests a division between a non-elite social class and an elite class.

The settlement at this site was very important in the Granada region and is considered to have been a center of power. Other sites that appear to correspond to subordinate settlements show less variation in funerary goods, and those goods never compare in quality or number with those in the rich tombs of the Cerro de la Encina. In some of these sites (e.g., Castellón Alto de Galera, with more than 100 individuals), the layout of the tombs, the wealth of grave lots, and divergent health markers and habitual physical activity patterns reflect apparent social stratification, but there is no evidence of an inferred elite with a level of affluence similar to that found at the Cerro de la Encina site. Something unique may have been unfold-

ing here. Fortunately, collections of individuals from the El Argar culture are gradually expanding, and this will allow broader testing of the results. Research should focus on the integrated study of stature, diet, systemic biological stress, and activity patterns in relation to the funerary goods and location of burials. These studies will also serve as a basis for comparisons with other sites from the Bronze Age in the Iberian Peninsula and the rest of Europe, thus contributing to a better understanding of a period when the formation of incipient states was entwined with the establishment of well-defined concepts and practices of social differentiation.

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9

The Pigi Athinas Tumuli Cemetery of Macedonian Olympus

Burial Customs and the Bioarchaeology of Social Structures at the Dawn of the Late Bronze Age, Central Macedonia, Greece

PARASKEVI TRITSAROLI

Archaeological investigation in the prehistoric Aegean spans a large volume of literature primarily focused on the southern Greek mainland, Crete, and Cyclades. Until the early 1980s, two principal trends influenced regional cemetery investigations and mortuary practices: the traditional cultural-historical orientation, which examines burial practices in connection with religious beliefs and ideas about afterlife (e.g., Kilian 1990; Mylonas 1973), and the diffusionist approach, which studies mortuary practices as a way of identifying cultural influences and defining cultural identities (e.g., Evans 1929; Marinatos 1974; Persson 1931). A different theoretical perspective in archaeological research emerged under the influence of processual archaeology, which emphasized the funerary architecture, variation in disposal and treatment of the dead, and grave wealth, which were all taken to be as indicative of the social status of the deceased (Graziadio 1991; Jacobsen and Cullen 1981; Mee and Cavanagh 1984, 1990; Nordquist 1990).

However, the relationship between burial practices and social organization is debatable and complex, to say the least (Parker Pearson 2000). Various postprocessual theoretical approaches, including contextual or interpretive archaeology, underscores how the living often use the funerary ritual as an arena where they engage in political, social, and economic competition (Hodder 1982; Parker Pearson 1982). As a consequence, energy expenditure or wealth deposited in graves may not be directly equated with social status held in life, since mortuary practices can become a way for living affines and even the deceased to acquire status. A similar perspective

in Aegean mortuary context has been introduced for the southern Greek mainland (Papathanasiou et al. 2012b; Schepartz et al. 2009; Voutsaki 1998, 2005).

During the last decade, bioarchaeologists in Greece have increasingly interpreted human skeletal remains in terms of context by integrating anthropological and archaeological data. The aim is to try to answer questions that relate to the lives, history, and population dynamics of ancient Aegean peoples (Buikstra and Lagia 2009; Lagia et al. 2014). Within this framework, the bioarchaeological analysis of burials from the tumuli cemetery at Pigi Athinas opens the door for investigating the association between biological correlates of social status and archaeological evidence of social differentiation.

Archaeological knowledge for the area of Macedonian Olympus (southern Pieria) during the Bronze Age (3300/3100–1100 BC) is uneven compared to other regions of Greece. Until recently, this area was archaeologically unstudied. Yet during the last thirty years, intense survey and archaeological research has brought to light significant evidence that reveals a diachronic occupational sequence that underscores the importance of the region from the Neolithic to the Roman period.[1] Several Bronze Age settlements and burial grounds were defined, including Krania, Valtos Leptokaryas, Pigi Artemidos, and Pigi Athinas (Poulaki-Pantermali 2001, 2003, 2008, 2013; Poulaki-Pantermali et al. 2004, 2010).

This chapter seeks to synthesize bioarchaeological and funerary pattern data in order to shed light on the nature of social organization at the Middle to Late Bronze Age (1620/1500 BC) site of Pigi Athinas (Middle to Late Bronze Age; 1620/1500 BC). Since the area of Macedonian Olympus is poorly investigated and multiple rescue excavations are in progress, we are far from reconstructing patterns of social organization for the Bronze Age society of Pigi Athinas. Thus, the aim of this study is to examine our current preliminary body of data and to propose initial observations and research questions regarding social structures through an integrated analysis of osteological evidence and burial customs. For instance, do demographic composition, variation of health status, lifestyle, and burial treatment vary? Do such patterns correspond to archaeological data that may indicate emergent or established forms of social differentiation, ranking, or social class? How were males and females represented? Were males and females grouped?

The cemetery of Pigi Athinas predates the "Mycenaeanized" funerary assemblages of Mount Olympus in Pieria (e.g., Spathes and Treis Elies).

During this latest phase of Late Bronze Age there is a broad range of evidence that suggests a noticeable change in social organization (Poulaki-Pantermali 2013). Thus, the bioarchaeological analysis of the cemetery at Pigi Athinas initiates a larger archaeological investigation of southern Pieria. Did local social transformations that took place at the beginning of the Late Bronze Age lead to the creation of the organizing principles of the "Mycenaeanized" societies, or did these new social roles emerge independent of what happened at the beginning of the Late Bronze Age, as a result of a new, influential, and dominant imported culture?

Burial Customs in the Middle and Late Bronze Age

During the Bronze Age, which lasted approximately three millennia (3000–1100 BC), major developments in the social, economic, and technological sectors of regional societies took place. Archaeological and historical investigations have identified three distinct civilizations that overlap in time and coincide with major geographic regions of the Aegean. The Cycladic civilization developed in the Aegean islands, while the Minoans occupied the island of Crete. At the same time, the civilization of the Greek mainland is characterized as Helladic. The Mycenaean civilization flourished in the Aegean during the Late Bronze Age, when the Greek mainland also enjoyed an era of prosperity.

It has been generally assumed that in northern Greece,[2] Neolithic (6700/6500–3300/3100 BC) and Early Bronze Age (3300/3100–2300/2200 BC) societies were essentially egalitarian. The emerging pattern indicates a gradual shift from dispersed settlements during the Neolithic to nucleated, larger communities during the Bronze Age, especially during the Middle and Late Bronze Age. Later in this period, there are archaeological signs of social complexity and small-scale settlement hierarchies as a result of political and economic changes in the Macedonian area (Andreou 2001; Andreou and Kotsakis 1996; Halstead 1995; Kotsakis and Andreou 1988). Bronze Age cemeteries were located at a distance from their associated settlements in order to separate the living from the dead and to make burial grounds visible. Generally, burials were homogenous in terms of grave architecture and wealth. Signs of clustering of burials suggestive of kinship marking in mortuary patterns are seen by the Early Bronze Age (Triantaphyllou 2001).

In the southern and central Greek mainland, Middle Helladic (2100–1700 BC) societies were egalitarian and their social structures were based

largely on kinship and descent (Voutsaki 1995, 1998). Middle Helladic mortuary practices were characterized by simplicity and the absence of material goods in the grave. Burials at this time were also characterized by a diversity and variety in form, indicating some kind of subtle social or ritual categorization rather than strict differentiation (Voutsaki 1998, 2005). Typically, in the Middle Helladic period, graves contained a single body in a flexed position (Graziadio 1991), but multiple burials and secondary treatments occasionally occurred (Voutsaki 2005). It was apparently not important to communicate social status, wealth, or authority in these burial rituals. An individual's roles and identity in society were most consistently tied to kinship relations. Ostentatious grave wealth or other material distinctions evidently were not used to legitimatize a person's identity in Middle Helladic death rituals or in society in general (Nordquist and Ingvarsson-Sundström 2005; Voutsaki 1998, 2005).

The timing of the transition from the Middle to the Late Bronze Age (1700/1500 BC) varies from region to region in northern Greece (Andreou et al. 1996, 2001; Grammenos et al. 1997) and the archaeological evidence of well-defined social structures and clear-cut hierarchy is limited. One of the major changes that manifested near the end of the Middle Bronze Age was the transformation of former habitation areas into burial grounds (Andreou et al. 1996; Dietz 1991; Maran 1995). This trend spread throughout different regions of the Greek mainland. The desire to create entirely new habitation areas (Dietz 1991) radically changed the use of settlements, since old settlement patterns were considered inadequate in the new order (Maran 1995). Thus, the mortuary reuse of former habitation areas is interpreted as a break in settlement continuity connected with the reconstruction and reorganization of occupational zones as social complexity increased (Maran 1995).

In the southern and central Greek mainland, the transition from the Middle to the Late Helladic I period (1700–1600 BC) was characterized by increased prosperity, marked differentiation among and within communities, increasing interaction and exchange networks, technological innovations, demographic growth, and more complex and newly established habitation areas (Rutter 1993; Touchais 1989; Voutsaki 2005). The causes of these developments seem to have been rooted in changing patterns of consumption and demand (e.g., specialization and more extensive systems of exploitation of agricultural and animal products) associated with the maintenance and emphasis on the new forms of varying collective group identities (Voutsaki 2005). Social status replaced kinship as the main criterion

of social organization in the Middle Helladic III (1800–1700 BC) through the Late Helladic I periods (1700–1600 BC) (Nordquist and Ingvarsson-Sundström 2005; Voutsaki 1998, 2005). Kinship and descent acquired new significance, as is evidenced by the introduction of family tombs (Voutsaki 1998, 2004). Age and gender relations were redefined. Sex and age divisions became more pronounced and asymmetrical, linked to emerging social differentiation and the creation and maintenance of asymmetries of power and access to resources in social life (Voutsaki 2004). Changes in mortuary practices include reuse of graves and secondary treatment of the dead, deposition of material wealth in burials, and an expanding diversity of ritual practices (Voutsaki 1998). The mortuary variability that has been observed for this period has been interpreted using "energy-expenditure" models (e.g., Tainter 1980) that estimate and compare the amount of effort, time, and resources expended in tomb construction to infer the social status of the deceased (Graziadio 1991; Mee and Cavanagh 1990).

This chapter focuses on tumuli, since they were the main organizing structure of the cemetery of Pigi Athinas. The origin of tumuli mortuary structures has been widely debated in the literature (Cavanagh and Mee 1998; Cultraro 2007; Gimbutas et al. 1997; Hammond 1967, 1974; Maran 1995; Müller 1989; Papadopoulos 1987; Pelon 1976, 1987; Wace 1913/1914). Tumuli appear in the Greek mainland in the Early Helladic II period (2650–2200/2150), probably as a result of influences from the north. In the region of East Macedonian Olympus, tumuli were used also during the Early Iron Age (1100–700 BC) (Poulaki-Pantermali 2007, 2008). In general terms, a tumulus is a circular construction consisting of a stone ring and a platform of earth and/or stones amassed within the ring. A tumulus is not a multiple burial but a structure that either is erected over one grave or covers multiple clusters of graves (Touchais 1989). According to Pelon (1987), the tumuli tradition reflects the family conception of the burial and often a particular social status.

The Site of Pigi Athinas

The site of Pigi Athinas in Pieria (literally meaning "spring of Athena") is located at the foothills of East Macedonian Olympus (Fig. 9.1), in proximity to the eponymous water source (Poulaki-Pantermali 2001, 2003, 2008, 2013). The archaeological excavations that were done at the site of Pigi Athinas from 1999 to 2009 brought to light important archaeological evidence that ranged from the Neolithic to post-Byzantine times. The site con-

Figure 9.1. Map of Greece showing the location of Pieria (central Macedonia, Greece). Map by P. Tritsaroli.

sisted of tumuli spanning the Middle to Late Bronze Ages (1620–1500 BC): in other words, before the "Mycenaeanization" of the region around Mount Olympus (Poulaki-Pantermali 2001, 2003, 2008, 2013; Poulaki-Pantermali et al. 2010). So far, the associated settlement of Pigi Athinas has not been located (Poulaki-Pantermali 2003, 2008). Thus, it is not possible to more directly explore social structures through the worlds of both the living and the dead. Yet archaeological evidence from the neighboring contemporary settlements of Valtos Leptokaryas and Krania include vessels, loom weights, fishing weights, knives, drills, fish hooks, metal objects (mostly personal accoutrements), and architectural remains represented primarily by monumental concentric enclosures (Poulaki-Pantermali et al. 2010) and fragments of buildings at Valtos.

The prehistoric cemetery of Pigi Athinas included five tumuli that appear to have been grouped in pairs. In particular, Tumuli 1 and 2 consti-

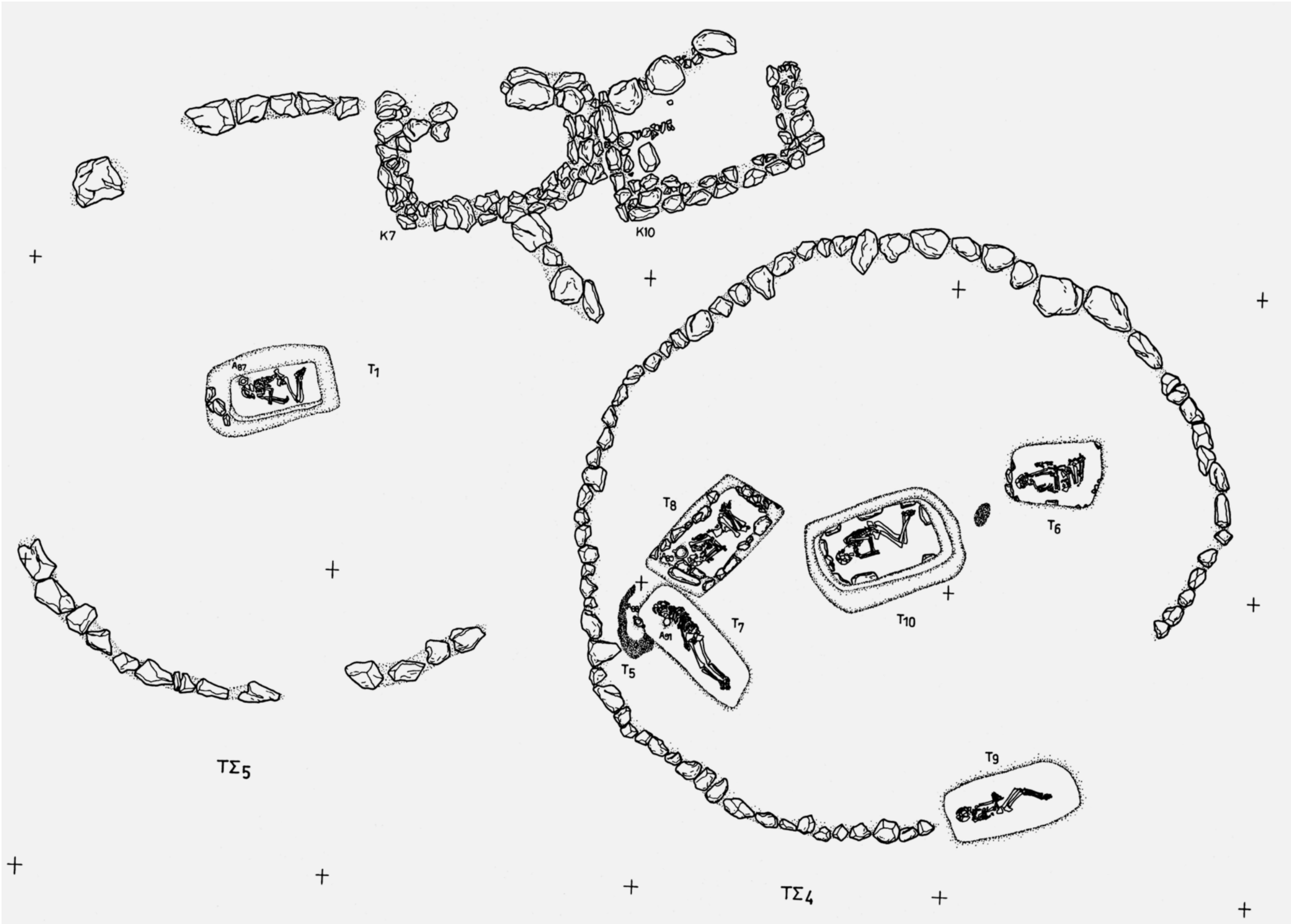

Figure 9.2. The pair of Tumulus 4 (*right*) and Tumulus 5 (*left*). Drawing by A. Efthimiadis, S. Vasileiadou, and N. Pitsiavas. Courtesy of E. Poulaki-Pantermali.

Figure 9.3. Tumulus 1. Photo courtesy of E. Poulaki-Pantermali.

tuted one pair and Tumuli 4 and 5 constituted another (Fig. 9.2). These tumuli were made of river cobbles, mainly marble stones (Poulaki-Pantermali 2003, 2008; Poulaki-Pantermali et al. 2010). One stone ring delimited each tumulus, which in turn, encircled one, three, or ten graves (Fig. 9.3). All tumuli contained a centrally placed grave with the same west-east cardinal orientation, sometimes with very slight deviations. Lateral graves were placed either parallel or vertical to the ring. Two superimposed layers of burials were identified in Tumulus 4, delimited by two different rings; the same central grave (Grave 10) was maintained for both phases.

Sixteen pit graves of various depths were excavated in the tumuli (Table 9.1). An arrangement of stones was identified atop most of burials. Central graves consisted of large, deep pits (depth ranged from 0.85 to 1.30 m) with internal steps to facilitate access to the grave (Fig. 9.4). These central tombs could be interpreted as examples of elaborate construction. The remaining eleven graves were shallow pits of simple, modest construction. In Tumulus 4, the earlier phase of use was associated with six graves (Graves 5 to 10); one was a deep pit (Grave 10) (Fig. 9.5) and five were shallow pits. The later phase of use involved only shallow pits in which to place the bodies (Graves 1 to 4). All of the funerary contexts contained single, primary in-

humations. The only exception was Grave 8 (Tumulus 4), where a second individual was identified in the funerary context. In these tumuli, the bodies were placed in a flexed position, laying on either their left or right sides. The offerings in the burials were mostly ceramic vessels, usually *kantharoi* (Poulaki-Pantermali 2008; Poulaki-Pantermali et al. 2010).

Figure 9.4. Tumulus 1, central grave 1. Photo courtesy of E. Poulaki-Pantermali.

Figure 9.5. Tumulus 4, central grave 10. Photo courtesy of E. Poulaki-Pantermali.

Materials and Methods

Bones were cleaned with water and were analyzed under normal light conditions. The analysis was conducted under the auspices of the Ephorate of Antiquities of Pieria (laboratory of Platamonas, southern Pieria). The skeletal sample of Pigi Athinas consists of seventeen adults; sixteen were found in situ as articulated skeletons and one was identified by a few non-articulated bones found in Tumulus 4 (Grave 8), associated with the primary burial. Bone preservation and completeness ranged from poor to very good (Table 9.1). The first step in the osteological analysis involved estimating basic skeletal parameters (age, sex, and stature). Sex determination was carried out using dimorphic aspects of the pelvis following the methods outlined by Buikstra and Ubelaker (1994; also Milner 1992; Phenice 1969); age at death was estimated from morphological changes of the pubic symphysis and the auricular surface of the os coxae (Brooks and Suchey 1990; Meindl and Lovejoy 1989; Todd 1920, 1921). Estimations of age at death were organized into three broad age categories: young adults (20–30 years), mature adults (30–40 years), and old adults (40–50 years). Stature calculations focused on intact femora, preferably from the left side (Trotter 1970). Robusticity indices were calculated for six postcranial bones (clavicle, humerus, radius, ulna, femur, and tibia) (Olivier 1960) along with observations of musculoskeletal stress markers

In our examination of pathological skeletal lesions, we used standard data collection methods for relatively complete skeletons based on Buikstra and Ubelaker (1994). Differential diagnosis of diseases was generally based on approaches such as those outlined by Aufderheide and Rodríguez-Martín (1998) and Ortner (2003). The lesions that we focused on in this analysis were porotic hyperostosis and cribra orbitalia, which indicate anemia-related nutritional deficiencies and chronic deprivation (Buikstra and Ubelaker 1994; Stuart-Macadam 1985). Linear enamel hypoplasias are reflective of developmental stress associated with infectious disease, malnutrition, or other kinds of relatively acute periods of stress and growth arrests in childhood (Hillson 1986). Periosteal new bone formation is a measurement of inflammatory responses resulting from systemic bacterial infection, localized traumatic injury, or other pathological processes. Skeletal trauma in the form of healed and unhealed broken bones (Lovell 1997; Merbs 1989), degenerative joint disease, musculoskeletal stress markers, vertebral osteoarthritis, and Schmorl's depressions serve as indicators of habitual activities and lifestyles (Hawkey and Merbs 1995; Kennedy 1989;

Table 9.1. List of tumuli, graves, and individuals at Pigi Athinas tumuli cemetery, including demographic characteristics and metric features

Number of tumuli, graves, and individuals	Grave construction	Offerings	Skeletal position	Preservation	Sex	Age	Stature	Clavicle RI[a]	Humerus RI	Radius RI	Ulna RI	Femur RI	Tibia RI
Tumulus 1, Grave 1	deep pit with steps	none	right flexed	poor	unknown	adult							
Tumulus 1, Grave 2	shallow pit	none	right flexed	poor	unknown	adult							
Tumulus 1, Grave 3	shallow pit	pottery	right flexed	poor	unknown	adult							
Tumulus 2, Grave 1	deep pit with steps	pottery	right flexed	poor	unknown	adult							
Tumulus 3, Grave 1	deep pit with steps	pottery	right flexed	poor	unknown	adult							
Tumulus 4, Grave 1	shallow pit	jewelry	left flexed	good	female	20–30	157 cm		22.0		14.8	19.3	22.4
Tumulus 4, Grave 2	shallow pit	pottery	right flexed	poor	female	adult			27.7				
Tumulus 4, Grave 3	shallow pit	pottery	unknown	poor	unknown	adult							
Tumulus 4, Grave 4	shallow pit	jewelry, pottery	left flexed	good	female	20–30							

(*continued*)

Table 9.1—*Continued*

Number of tumuli, graves, and individuals	Grave construction	Offerings	Skeletal position	Preservation	Sex	Age	Stature	Clavicle RI[a]	Humerus RI	Radius RI	Ulna RI	Femur RI	Tibia RI
Tumulus 4, Grave 5	shallow pit	pottery	unknown	poor	unknown	adult							
Tumulus 4, Grave 6	shallow pit	none	right flexed	poor	female	40–50	156 cm			22.4		19.9	
Tumulus 4, Grave 7	shallow pit	pottery	right flexed	very good	male	30–40	166 cm	29.6	21.5		14.4	20.4	27.1
Tumulus 4, Grave 8.1	shallow pit	pottery	right flexed	good	male	40–50	167 cm		25.0	24.2	14.2	20.1	24.3
Tumulus 4, Grave 8.2			unknown	poor	unknown	adult							
Tumulus 4, Grave 9	shallow pit	none	left flexed	good	female	30–40	159 cm	26.8				20.3	
Tumulus 4, Grave 10	deep pit with steps	none	right flexed	good	male	40–50	169 cm	26.7	25.1	23.6	13.9	18.6	
Tumulus 5, Grave 1	deep pit with steps	pottery	right flexed	very good	male	40–50	161 cm	28.6	26.9		15.5	20.3	26.1

[a]Robusticity index.

Rogers and Waldron 1995; Waldron 2008). Dental diseases (dental caries, calculus, alveolar bone resorption, and vertical and horizontal bone loss) and antemortem tooth loss (Brothwell 1981) were used to reconstruct basic patterns of oral health and diet.

Skeletal lesions were inventoried by presence or absence, by individual and by skeletal element (left and right). The crude prevalence calculations reflect the number of observed lesions (n) divided by the number of observable lesion sites (N). We analyzed degenerative joint disease by individual and by joint (left and right) when at least one articular surface of the joint was preserved. Vertebral osteoarthritis and Schmorl's depressions were examined by vertebral segment (cervical, thoracic, and lumbar). Musculoskeletal markers were scored on seven bones and groups of bones (clavicle, humerus, radius, ulna, hand, femur, and calcaneus). Because of the relatively poor preservation of the skeletons, the examination of musculoskeletal markers could not be made by muscle group or movement pattern. Dental diseases are reported by teeth/sockets and by individuals. Tables 9.2 to 9.8 present results for adults (entire sample), females, males, and undetermined individuals. The last group includes individuals for whom it was not possible to determine age at death and sex either because the pelvis was not preserved at all or because it was extremely fragmented.

Preliminary results of the skeletal analysis are provided elsewhere (Tritsaroli 2010). Overall results are shown in Tables 9.1 through 9.8. In addition, particular lesions for some individuals are included independently in the description of each tumulus in order to underline the location of these individuals in the burial ground and associate them with archaeological evidence such as placement and construction of the grave and disposal of the body. Poor preservation did not allow for complete observations of the skeletal remains from Tumuli 1, 2, and 3. Most of the results presented below come from Tumuli 4 and 5. All frequencies for females presented in Tables 9.1 to 9.8 were calculated from Tumulus 4; frequencies for males were generated from Tumuli 4 and 5. The differences in tomb architecture and placement, orientation, and disposal of the body were used as basic indicators of social status. Comparative data from other Bronze Age cemetery samples from Greece were used when available.

Results

Demography and Paleopathology

The analysis revealed five females, four males, and eight adults of indeterminate sex and age. Females represented all age categories (two individuals in the 20- to 30-year-old age class, one individual in the 30- 40-year-old age class, and one individual in the 40- to 50-year-old age class), while males were estimated either as mature (one individual in the 30- to 40-year-old age class) or old (three individuals in the 40- to 50-year-old age class) (Table 9.1). The average stature for males was 166 cm (N = 4); for females it was 157 cm (N = 5) (Table 9.1). The stature of females and males from Pigi Athinas fall within the ranges known for Bronze Age sites in Greece (Lagia et al. 2007; Papathanasiou et al. 2012a).

Porotic hyperostosis was expressed mainly on the superficial cranial vault surface in the form of regular pitting seen in small circumscribed areas of the frontal, parietal, and occipital bones, often parallel to the sutures. The highest crude prevalence was recorded for the parietal (58.5 percent) and frontal (54.5 percent) bones (Table 9.2). Comparison of the sexes showed that porotic hyperostosis affected more females than males. No cases of cribra orbitalia were observed. Dental enamel hypoplasias were relatively common (23 percent); they affected anterior (N = 32) and posterior (N = 37) teeth equally (Table 9.3). Differences were observed between males and females. Female crude prevalence was 30 percent, while only 16 percent of males were affected. Also, posterior teeth in females (N = 28) were affected six times more often than in males (N = 5). Also, the largest number of hypoplastic teeth affected per individual was found among females.

Periosteal reactions were manifested on long bones by mild abnormal new bone deposits or by a longitudinally striated appearance without evidence of cloacae. Only the lower limbs were affected (Table 9.4). The highest frequency was recorded for the tibia (52.4 percent), followed by the fibula (31.6 percent) and the femur (15.4 percent). The lesion seems to have been more common among females: it affected the lower limb bones of all females. In contrast, only the tibiae and fibulae were affected by this type of lesion among males.

A 20- to 30-year-old female displayed various lesions of the skull, ribs, and vertebra and nonspecific infections recognized as periostitis (Fig. 9.6). In particular, reactive new bone was recorded on the endocranial surfaces of the occipital, parietal, and temporal bones adjacent to the lambdoidal

Table 9.2. Oral health patterns in the Pigi Athinas skeletal sample

Condition	Adults			Females			Males			Undetermined		
	N	n	%	N	n	%	N	n	%	N	n	%
Per number of teeth/tooth sockets												
Caries	306	30	10	137	23	16.8	102	4	3.9	67	3	4.5
Calculus	308	43	14	138	8	5.8	102	8	7.8	68	27	39.7
Antemortem tooth loss	331	18	5	147	6	4.1	116	12	10.3	68	0	0
Alveolar bone resorption	219	9	4	110	9	8	109	0	0	—	—	—
Per number of individuals												
Caries	12	10	83	5	5	—	4	2	—	3	3	—
Calculus	12	6	50	5	3	—	4	2	—	3	1	—
Antemortem tooth loss	12	5	42	5	2	—	4	3	—	3	0	—
Alveolar bone resorption	9	2	22	5	2	—	4	0	—	—	—	—

Table 9.3. Dental enamel hypoplasia patterning in the Pigi Athinas skeletal sample

Condition	Adults			Males			Females			Undetermined		
	N	n	%	N	n	%	N	n	%	N	n	%
Per number of teeth												
Dental enamel hypoplasia	304	69	23	100	16	16	136	41	30	68	12	18
Per number of individuals												
Dental enamel hypoplasia	12	6	50	4	2	—	5	3	—	3	1	—

Table 9.4. Hypertrophic lesions of the cranium in the Pigi Athinas skeletal sample

Condition	Adults			Females		Males		Undetermined	
	N	n	%	N	n	N	n	N	n
Per number of bones									
Cribra orbitalia	20	0	0	10	0	8	0	2	0
Porotic hyperostosis									
Frontal	22	12	54.5	10	6	8	4	4	2
Parietal	24	14	58.3	10	8	8	4	6	2
Occipital	11	4	36.4	5	3	4	1	2	0
Per number of individuals									
Cribra orbitalia	10	0	0	5	0	4	0	1	0
Porotic hyperostosis									
Frontal	11	6	54.5	5	3	4	2	2	1
Parietal	12	7	58.3	5	4	4	2	3	1
Occipital	11	4	36.4	5	3	4	1	2	0

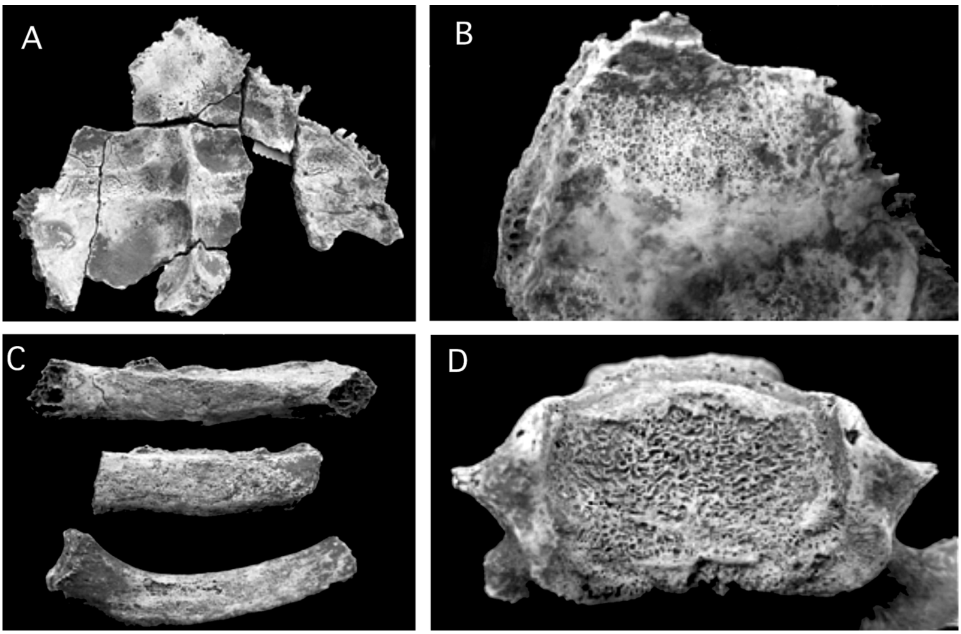

Figure 9.6. Reactive new bone on the endocranial surfaces of the occipital (A) and temporal (B) bones; new bone formation on the medial surfaces of three ribs (C); and lytic lesions on the upper surface of the 3rd cervical vertebra (D). Tumulus 4, grave 4, 30- to 40-year-old female.

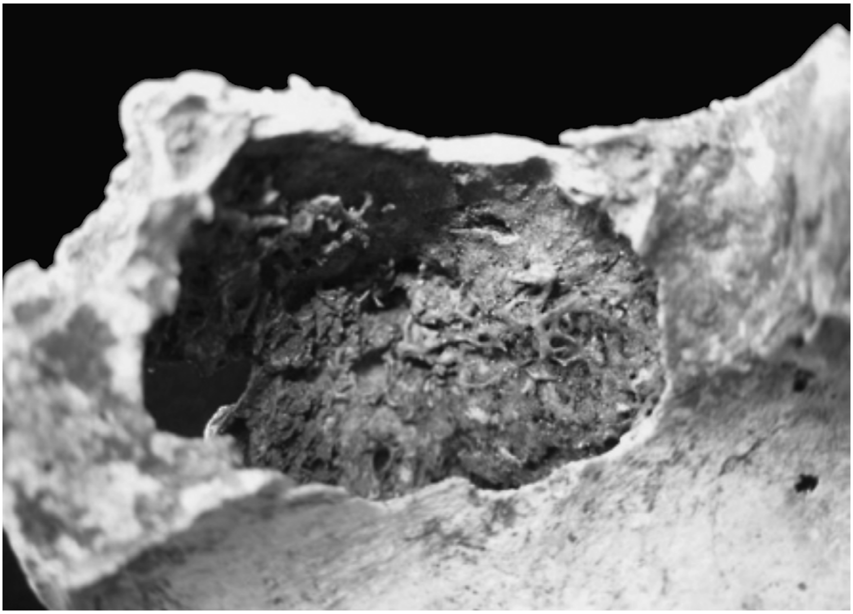

Figure 9.7. Spicule-like new bone formation in maxillary sinus possibly consistent with chronic sinusitis. Tumulus 4, grave 8, 40- to 50-year-old male. Photos by P. Tritsaroli.

and sagittal sutures. Hyperostotic lesions also affected the external surfaces of the occipital and parietal bones around lambda. The same types of lesions were present on the supraorbital margins. On the postcranial skeleton, new bone formation was observed on the pleural surface of three ribs (a similar case is reported from a Mycenaean burial at Velestino) (Papathanasiou et al. 2012a). Finally, lytic lesions were found on the upper and lower surfaces of all nineteen preserved vertebral bodies. It is not certain if all these features had a common etiology and it is not possible to attribute these lesions to a specific disease. Primary and secondary nonspecific infections should probably be considered as possible causative agents. Also, a 40- to 50-year-old male was affected by bilateral new bone formation in maxillary sinuses, perhaps suggesting chronic sinusitis or a similar inflammatory disease (Fig. 9.7) (Boocock et al. 1995).

Although the factors conditioning degenerative joint disease are complex (age, genetic predisposition, obesity), patterns of activity seem to play a major role. Degenerative joint disease at Pigi Athinas was generally manifested by surface porosity and lipping. Joint surface destruction and osteophyte formation on the margins of the joints occurred in a few cases (e.g., bilateral destruction of the articular surface was recorded for the

Table 9.5. Patterns of abnormal periosteal new bone formation in the Pigi Athinas skeletal sample

Bone	Adults			Females		Males		Undetermined	
	N	n	%	N	n	N	n	N	n
Per number of bones									
Humerus	25	0	0	10	0	8	0	7	0
Radius	24	0	0	10	0	8	0	6	0
Ulna	25	0	0	10	0	8	0	7	0
Femur	26	4	15.4	10	4	8	0	8	0
Tibia	21	11	52.4	10	6	8	4	3	1
Fibula	19	6	31.6	9	2	8	4	2	0
Per number of individuals									
Humerus	13	0	0	5	0	4	0	4	0
Radius	12	0	0	5	0	4	0	3	0
Ulna	13	0	0	5	0	4	0	4	0
Femur	13	2	15.4	5	2	4	0	4	0
Tibia	11	7	63.6	5	3	4	3	2	1
Fibula	11	3	27.3	5	1	4	2	2	0

acromial end of the clavicle for the old male from Tumulus 5). Degenerative lesions (Table 9.5) affected mostly the shoulder (40 percent), the foot (37.5 percent), the sternoclavicular joint (36.4 percent), the hip (30.8 percent), and the ankle (28.6 percent). Comparison of the sexes revealed that females displayed more lesions on the upper skeleton, while males were more affected on the shoulder and lower limbs. Spinal osteophytosis and Schmorl's depressions occurred on almost all vertebral segments (Table 9.6), and males were more commonly affected than females. Analyses of robusticity indices were extremely inadequate due to the poor preservation of the sample (Table 9.1). The only observation that can be made from the available data is that some values were elevated for male clavicles and tibiae. The only two skeletal traumatic lesions found in the sample involved an old man who experienced an evidently trauma-induced ankylosis of two right hand phalanges and fractures on three left ribs that had healed by the time of death (Fig. 9.8).

The distribution of enthesopathies at Pigi Athinas (Table 9.7) was similar to that observed for degenerative changes: osteophytes at the Achilles' tendon (41.7 percent) and an imprint of the costoclavicular ligament (33.3 percent) were the most frequently recorded conditions. However, enthe-

Table 9.6. Distribution of degenerative joint disease lesions in the Pigi Athinas skeletal sample

Location	Adults			Females		Males		Indeterminate	
	N	n	%	N	n	N	n	N	n
Per number of bone									
TMJ	20	4	20	10	0	8	4	2	0
Glenohumeral	20	8	40	10	4	8	4	2	0
Sternoclavicular	11	4	36.4	5	1	6	3	-	-
Acromioclavicular	14	1	7.1	6	1	8	0	-	-
Elbow	21	3	14.3	10	0	8	3	3	0
Wrist	23	1	4.3	10	0	8	1	5	0
Hand	24	3	12.5	10	0	8	1	6	2
Hip	26	8	30.8	10	2	8	4	8	2
Knee	21	4	19	9	0	8	3	4	1
Ankle	14	4	28.6	6	0	8	4	-	-
Foot	16	6	37.5	7	2	8	4	1	0
Per number of individuals									
TMJ	10	2	20	5	0	4	2	1	0
Glenohumeral	11	4	36.4	5	2	4	2	2	0
Sternoclavicular	7	3	42.9	4	1	3	2	-	-
Acromioclavicular	8	1	12.5	4	1	4	0	-	-
Elbow	12	1	8.3	5	0	4	1	3	0
Wrist	12	1	8.3	5	0	4	1	3	0
Hand	12	2	16.7	5	0	4	1	3	1
Hip	13	4	30.8	5	1	4	2	4	1
Knee	12	3	25	5	0	4	2	3	1
Ankle	7	2	28.6	3	0	4	2	-	-
Foot	9	3	33.3	4	1	4	2	1	0

sopathies cannot be attributed to specific physical activities or economic occupations in the past (Kennedy 1989). This is especially true in the sample examined here, as enthesopathic lesions were collected by bone and not by muscle group or movement pattern.

Dental diseases presented in the Pigi Athinas sample showed unusually high frequencies of supragingival calculus (14 percent) and dental caries (10 percent) (Table 9.8). It is worth noting that 27 teeth with calculus deposits came from a single adult of unknown sex. Antemortem tooth loss and alveolar bone resorption were less common; they affected 5 percent and 4

Figure 9.8. Antemortem rib fractures. Tumulus 5, 40- to 50-year-old male. Photo by P. Tritsaroli.

Table 9.7. Vertebral degenerative joint disease in the Pigi Athinas skeletal sample

Pathological Condition	Adults			Females		Males		Undetermined	
	N	n	%	N	n	N	n	N	n
Per vertebral segment									
CV OA	11	5	45.5	5	2	4	3	2	0
TV OA	11	8	72.7	5	4	4	4	2	0
LV OA	11	5	45.5	5	2	4	3	2	0
CV SD	11	0	0	5	0	4	0	2	0
TV SD	11	3	27.3	5	1	4	2	2	0
LV SD	11	1	9.1	5	0	4	1	2	0
CV trauma	11	0	0	5	0	4	0	2	0
TV trauma	11	0	0	5	0	4	0	2	0
LV trauma	11	0	0	5	0	4	0	2	0
CV ankylosis	11	0	0	5	0	4	0	2	0
TV ankylosis	11	0	0	5	0	4	0	2	0
LV ankylosis	11	0	0	5	0	4	0	2	0

Note: CV = cervical vertebrae; TV = thoracic vertebrae; LV = lumbar vertebrae; OA = osteoarthritis; SD = Schmorl's depressions.

Table 9.8. Musculoskeletal marker patterning of major postcranial muscles, tendons, and ligaments in the Pigi Athinas skeletal sample

Muscle/ligament examined	Location	Adults			Females		Males		Undetermined	
		N	n	%	N	n	N	n	N	n
Per number of bones/groups of bones										
Costoclavicular ligament	Clavicle	18	6	33.3	10	2	8	4	—	—
Pectoralis major	Humerus	23	2	8.7	10	0	8	2	5	0
Biceps brachii	Radius	18	2	11.1	10	0	8	2	—	—
Brachialis	Ulna	21	2	9.5	10	2	8	0	3	0
Flexor ligament	Hand	23	3	13.0	10	2	8	1	5	0
Linea aspera	Femur	26	0	0	10	0	8	0	8	0
Achilles' tendon	Calcaneus	12	5	41.7	4	1	8	4	—	—
Per number of individuals										
Costoclavicular ligament	Clavicle	9	4	44.4	5	2	4	2	—	—
Pectoralis major	Humerus	12	1	8.3	5	0	4	1	3	0
Biceps brachii	Radius	9	1	11.1	5	0	4	1	—	—
Brachialis	Ulna	11	1	9.1	5	1	4	0	2	0
Flexor ligament	Hand	12	2	16.7	5	1	4	1	3	0
Linea aspera	Femur	13	0	0	5	0	4	0	4	0
Achilles' tendon	Calcaneus	6	3	50	2	1	4	2	—	—

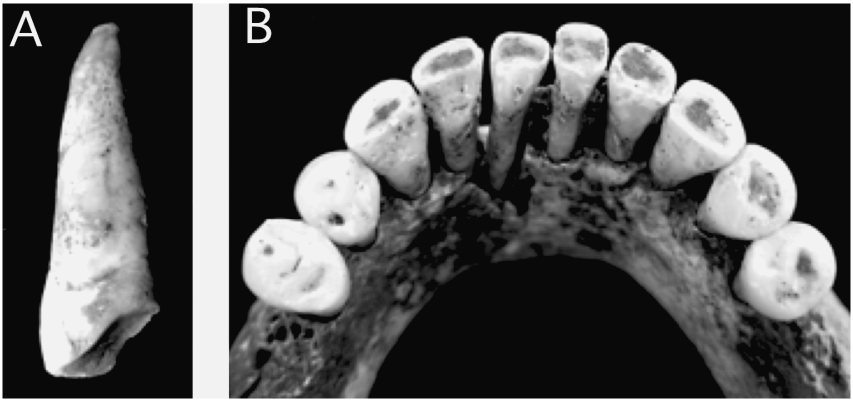

Figure 9.9. Maxillary central incisor showing V-shaped groove (A) and mandibular incisors with advanced wear and considerable loss of crown height (B). Tumulus 4, Grave 9, 30- to 40-year-old female. Photo by P. Tritsaroli.

percent of observable tooth positions, respectively. Dental caries were notably more frequent among females (16.8 percent) than among males (3.9 percent). These patterns were coupled with a greater rate of periodontal disease among the women in the sample (8 percent).

One female and one male at Pigi Athinas were found with unusual dental wear patterns and dental trauma. In the first case, a 30- to 40-year-old woman showed lingual wear of the maxillary incisors and maxillary right canine sufficient to remove enamel and expose secondary dentin on the left side. Her maxillary central incisors had longitudinal V-shaped grooves into which the occlusal edge of the mandibular incisors would fit. The central maxillary incisors demonstrated signs of chipping of the crown and rounding of the fractured edges, suggesting continued wear of the broken surface after the fracture. In addition, the mandibular incisors presented wear with considerable loss of crown height while the left canine was slightly beveled anteriorly (Fig. 9.9).

In the second case, a 40- to 50-year-old man had abnormal tooth wear complicated by secondary dentin exposure on the maxillary dentition that suggested extramasticatory use (Fig. 9.10). The left maxillary lateral incisor and canine were worn on the lingual surface. Central and right maxillary lateral incisors were affected by particularly severe wear complicated by secondary dentin exposure. The right maxillary incisors demonstrated longitudinal grooving of the occlusal surface. In addition, the incisors had signs of chipping of the crown, and the regions of chipping were also worn. Significant wear-related loss of the mandibular incisors, however, did not

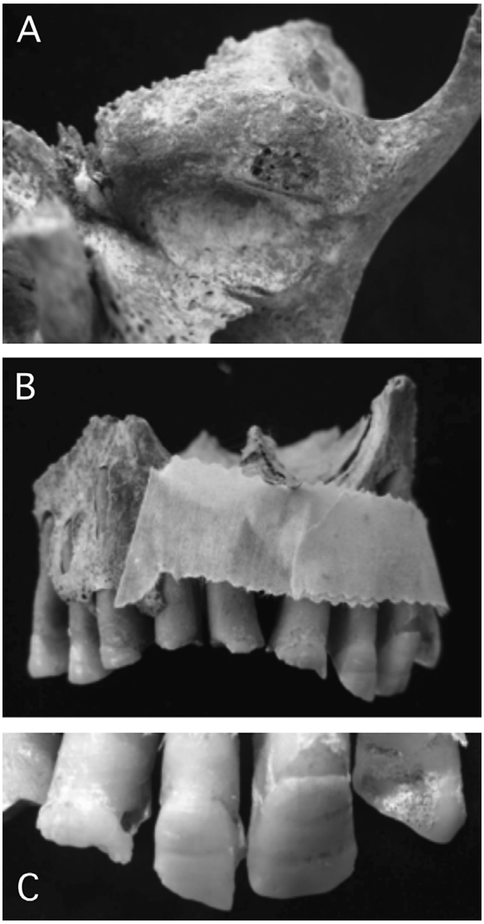

Figure 9.10. Temporomandibular joint (left temporal bone) (A), dental trauma on the maxillary anterior teeth (B), interproximal caries on left central maxillary incisor, and enamel hypoplasia on left second maxillary incisor and canine (C). Tumulus 5, 40- to 50-year-old male. Photo by P. Tritsaroli.

have the same beveling, suggesting that anterior teeth of the upper dentition were probably used independently. Degenerative lesions were observed on his left temporomandibular joint, possibly consistent with the repetitive and continuous use of teeth as tools for habitual or occupational activities.

Tumuli, Graves, Burials, and Skeletons

The skeletal evidence was also analyzed across tomb architecture and placement and the orientation and disposal style of the body. Despite the small sample size, some interesting observations emerged when the archaeological evidence was compared to the skeletal evidence at Pigi Athinas. In Tumuli 4 and 5, bodies were placed in a flexed position on their right or left sides. Placement on either side seemed to vary randomly among women,

but all four males were placed in a flexed position on their right sides. Among the four males, two occupied central elaborate graves, while females were systematically buried in simpler pits at the periphery of tumuli. Differences were also observed in terms of orientation of graves. The central elaborated pits were systematically oriented west-east. A common orientation was adopted for the individuals buried in these graves, two of which were old males. All of the differences observed in the dental and skeletal health of males and females at Pigi Athinas correlated with archaeological evidence of tomb type, placement of the grave, orientation, and disposal of the body. The following paragraphs describe the distribution of general archaeological and skeletal features by tumuli.

Tumulus 1

Tumulus 1 contained three burials. Lateral graves were adjacent to the ring of the tumulus. In each grave, skeletons were placed in a flexed position in their right sides. Skeletal observations were limited to the individual from the central burial (Fig. 9.3). Dental enamel hypoplasia affected twelve of the twenty-five teeth observed. Because of the poor preservation of the bones, no further observations were possible.

Tumulus 2

Tumulus 2 included one central grave. The skeleton was found in a flexed position, placed on the right side. Dental calculus affected all the twenty-seven preserved teeth (twelve maxillary and fifteen mandibular) of the individual from Tumulus 2 (a possible male). In all affected teeth, calculus deposits were of small size, with the exception of the three preserved mandibular incisors, for which calculus was of medium size.

Tumulus 3

Tumulus 3 included one central grave. The skeleton was found in a flexed position, placed on the right side. No observations were possible for the individual from the Tumulus 3.

Tumulus 4

Tumulus 4 included ten graves that corresponded to two temporally distinct phases of use. During the early phase, the tumulus contained six burials (one central and five lateral). Among these burials, three belonged to men, two contained women, and one contained an adult of unknown sex. The five lateral graves of the earlier phase included males and females span-

ning only the middle adult (30–40 years) and old adult (40–50 years) age categories. All identified males were buried in a flexed position laying on their right side. During the later phase of use, four graves were added to Tumulus 4, three of which belonged to women. Two of these individuals were in a flexed position, lying on their left side, mirroring the woman from Grave 9 of the preceding phase. The young female who displayed multiple lesions on the skull, ribs, vertebrae, and lower limbs was found in Grave 4 of this tumulus. This was the only burial in the sample where personal accoutrements and pottery were placed conjointly as offerings. The central Grave 10 (Fig. 9.5) held a 40- to 50-year-old male who was placed on his right side. He was the tallest individual of the sample, but not the most robust. This was one of the two males whose teeth were affected by enamel hypoplasia (eight of twenty-nine preserved teeth) (Table 9.2). Osteoarthritis and musculoskeletal markers affected his chest, his vertebral column, and his lower limbs. In particular, vertebral osteoarthritis was recorded on all segments of the spine, degenerative joint disease affected the left knee and both ankles, and feet, and enthesopathies were present in the form of bilateral ligament imprints on clavicle.

Tumulus 5

Tumulus 5 included a central grave that belonged to a 40- to 50-year-old adult male interred in a flexed position on his right side. This man possessed some of the highest robusticity indices in the sample. The skeleton exhibited a similar paleopathological profile as the male from the central Grave 10 of Tumulus 4 but with more advanced lesions. He suffered from metabolic stress during childhood, as is reflected in dental enamel hypoplasia (in 8 of 12 teeth). Most posterior mandibular teeth were lost antemortem (10 of 24 teeth/sockets). Nonspecific periosteal lesions were present on the tibiae and fibulae. In addition, this man displayed degenerative joint disease of the sternoclavicular joint, hands, hip, knees, and feet, while he was affected by enthesopathies on the radius, hands, and calcaneus. The two traumatic lesions described earlier were observed in his remains.

Discussion

The mortuary and skeletal sample from the tumuli cemetery at Pigi Athinas may be small and statistical testing is constrained. Yet a qualitative and contextual engagement with the data points out two important issues with regard to paleopathology, burial practices, and social organization: 1) dis-

tinct skeletal characteristics appear to be related to female and male activities and lifestyles; and 2) evidence of differential burial treatment occurred along a dual axis of age at death and sex.

The most frequently observed dental pathological conditions at Pigi Athinas were dental caries and dental calculus. These conditions tend to be mutually exclusive because the mechanisms that produce them are different. Thus, comparing the rates of the two conditions in a population can provide important information about dietary patterns (Hillson 1979). Results from other Greek sites and differences between sexes suggest that it would be unwise to assume that people at Pigi Athinas had adopted a diet with proportionally elevated meat consumption. Analysis of dental health and dietary reconstructions from several Greek Bronze Age skeletal series revealed predominantly terrestrial subsistence strategies focused on C_3 plants, involving the consumption of both agricultural and animal products without significant contributions of meat or marine protein. This reliance on carbohydrate-rich cultigens expanded to coastal sites, suggesting that a terrestrial type of diet was adopted and enriched by agricultural foods (Lagia et al. 2007; Lagia and Cavanagh 2010; Papathanasiou 2015; Papathanasiou et al. 2012b; Petroutsa et al. 2009; Triantaphyllou 2001; Triantaphyllou et al. 2008).

Osteological and biochemical evidence from the mainland of southern Greece (Papathanasiou et al. 2012b; Schepartz et al. 2009; Triantaphyllou et al. 2008) showed differences in diet according to sex and hierarchy. Thus, females had poorer dental health compared to males, who seem to have incorporated more animal protein in their diet. The differences observed between sexes at Pigi Athinas could indicate that women consumed cariogenic foodstuffs while men were proportionally greater meat consumers. However, the small sample size and the absence of biochemical analysis at Pigi Athinas does not allow further discussion of the differential access in food categories for males and females.

Frequencies of dental diseases at Pigi Athinas were higher compared to those of other prehistoric populations from Greece (Papathanasiou 2009; Papathanasiou et al. 2012a; Triantaphyllou 2001; Triantaphyllou et al. 2008). A similar pattern of dental diseases was found among the Roman sample examined from the same site, which exhibited very high rates of dental calculus and dental caries (Tritsaroli 2014). This may suggest that over time, factors other than diet might have shaped the oral health of the people who lived at Pigi Athinas. Thus, environmental and geological conditions, such

as water and soil quality or cultural ideas about oral health maintenance, are worth considering in future work.

Dental enamel hypoplasias reflect childhood experiences such as nutritional deficiency, infectious disease, or a combination of both that provoked metabolic disruption (Goodman et al. 1980; Goodman and Rose 1990, 1991; Hillson 1986; Larsen 2015). Frequencies of enamel hypoplasia and abnormal periosteal new bone formation suggest that biological stress and infection was relatively common among people at Pigi Athinas, in contrast to several other prehistoric populations from Greece (Papathanasiou 2009; Papathanasiou et al. 2012a; Triantaphyllou 2001). Always bearing in mind the small sample size from Pigi Athinas, enamel hypoplasia might indicate that sex and probably status differentiation started early in life and was more intensely embodied by female children. In addition, nonspecific infectious lesions on the postcranial skeleton could signify that women had a greater risk of experiencing infectious agents during adult life.

The bioarchaeological evidence of habitual activities revealed typical tasks for Greek prehistoric skeletal assemblages (Triantaphyllou 2001), such as food acquisition, food processing, food preparation, and craft production, as evidenced by degenerative changes predominantly in the upper body. Degenerative lesions in the hip and lower limbs could be reasonably consistent with chronically physically stressful agricultural activities such as constructing and clearing fields, tilling, planting, and harvesting. Similarly, the use of the anterior dentition as a supplemental tool in some occupational activities can be linked to role-based behaviors such as food processing or craft production (Lukacs and Pastor 1988; Ortner 2003) including the production of cordage and other materials necessary for the construction of hunting and collecting gear (Larsen 1985). At Pigi Athinas, the distribution and frequency of degenerative diseases, enthesopathies, and skeletal and dental trauma showed that individuals were preferably subject to stress on the upper skeleton and feet and that they occasionally used their dentition as a tool. Because of the small sample size, subtle differences between men and women cannot be said to be indicative of specialized occupational activities, but the possibility of differentiated patterns of body use should be considered in future research.

The two sexes were equally represented in the cemetery of tumuli at Pigi Athinas. This could, at first glance, be seen as a reflection of an egalitarian society in which men and women engaged in relatively equal social relationships. Yet the spectrum of paleopathological features examined in

terms of age and sex demonstrated variations in nutritional status, other forms of morbidity, and occupational stress that instead probably reflected some kind(s) of role differentiation in this prehistoric community. Females exhibited poorer dental and skeletal health than males did. Women showed more signs of metabolic disorders in the form of enamel hypoplasias and porotic hyperostosis. Degenerative lesions were located mostly on superior skeletal elements, especially the upper limbs. The men studied here evidently lived longer than the women and probably had better nutrition and health, though degenerative diseases and musculoskeletal markers showed mechanical stress on the vertebral column and lower limbs of these males.

The distribution of funerary space at Pigi Athinas showed two principal groups of tumuli. The first group included tumuli with one burial (Tumuli 2, 3, and 5) and the second group contained tumuli with more than three burials (Tumuli 1 and 4). Tumuli with one burial indicated that the funerary structure was used for just one event, while tumuli with more burials suggested a successive utilization for multiple events. In the second case, lateral graves seemed to be organized around the central one. This observation is consistent with the distribution of tumuli in pairs. Each pair was formed by one tumulus that included one single, isolated burial and another tumulus with more burials. On the one hand, the distribution in pairs created a rather homogenous cemetery structure. On the other hand, the grouping of graves was unequal since the pair of Tumuli 4 and 5 included more than half of the graves of the sample. Thus, burial distribution in the tumuli provides hints of inequality.

The clustering of graves and the numerical distribution of individuals in and between contexts raises questions about the social or family grouping of the deceased. Kin ties and social status seem to have been the primary considerations in the clustering of burials (Nordquist and Ingvarsson-Sundström 2005) for this period. However, the term "family" is rather vague (Mee and Cavanagh 1990) and not every member of a family, whether an adult or child, would necessarily be buried in the tumulus. The absence of subadults from the small skeletal sample at Pigi Athinas does not allow for inferences to be made about possible segregation and the particular social status of children. Nevertheless, the absence of subadults from the portions of the cemetery excavated to date does not exclude the possibility that adult graves were grouped according to kin ties. At present, there is no reliable evidence available to discuss the degree of kinship, defined either patrilineally or matrilineally. In this sample, unique nonmetric skeletal and dental traits, which are often used in kinship studies, were rare and iso-

lated.[3] These findings point to the likelihood that the individuals buried in these tumuli were rather morphologically alike and possibly genetically homogenous.

The addition of a new series of graves in Tumulus 4 was achieved vertically, not horizontally. That means that the living decided to construct a second ring and introduced a second group of burials instead of creating another tumulus. Consequently, the placement of Tumulus 4 next to the Tumulus 5 was strictly maintained and the distribution of tumuli in pairs remained stable. In addition, males and females with apparently distinctive lifestyles were chosen to be grouped, probably representing subgroups of this prehistoric society. We may weigh the likelihood that these individuals belonged to the same family, household, or lineage and that this was the factor that structured the utilization of a defined funerary structure.

The distribution of males and females in terms of grave construction and body positioning showed several variations. According to the available data, it seems that old males mostly occupied elaborate constructed graves. Conversely, most women were placed in simpler, shallow graves. In addition, all individuals from central graves were buried lying on their right side in a flexed position, which was also the general preference for men. Central graves, at least in the pair of Tumuli 4 and 5, belonged to old males. In contrast, women were mostly placed in lateral graves and interred on their left sides. This difference between males and females is reported elsewhere in Middle Helladic Greece (Ruppenstein 2010). Finally, in the early phase of Tumulus 4, male burials were grouped. The differences observed between males and females in terms of dental health and lifestyle correlated with the placement of the burials, the grave architecture, and the disposal of the bodies. If we proceed with the notion that the energy put into the construction of the grave and its location in the cemetery could be indicative of the status of the deceased (Cavanagh and Mee 1998), then males of a rather advanced age were likely associated with a greater range of social dimensions involving respect, social significance, and power in both life and death. However, the placement of the burials and the construction of the graves, in association with the common paleopathological profile and homogeneity in grave goods, are not sufficient to argue for the particular social status of any of the male individuals, whether they were buried at the center of a tumulus or not.

Grave 8 (Tumulus 4) included the primary burial of an old male and a second individual identified by a few small fragments of long bones (e.g., ulna, femur) and the os coxae. The presence of a fragmentary second indi-

vidual could be seen as a sign of reuse of the grave and the secondary burial of the first occupant. The literature indicates an emphasis on genealogical descent and ancestors (Voutsaki 1995), and inclusion of the remains of an ancestor in a new burial could have had key significance along these lines, especially considering that the second, more recent, individual was one of the old adult males. Perhaps the bones of an ancestor added some kind of legitimacy or social clout to the recently deceased or were a symbolic connection to past generations. However, the skeletal and archaeological evidence are insufficient to argue for this hypothesis, and no clear link can be established between these two individuals. What we can say is that the presence of a second individual in this grave is probably not accidental.

Similarities to and differences from the situation at Pigi Athinas are observed at other sites in southeastern Pieria. The tumulus excavated at the contemporary settlement of Valtos Leptokaryas (12 km north of the site) included three single adult burials and demonstrated similar patterns in terms of the distribution of paleopathological lesions, the absence of subadults, the presence of both sexes, and the age of the deceased (an old male and a younger female) (Tritsaroli 2010). In contrast, the central grave of the tumulus at Valtos Leptokaryas belonged to a female individual. The slightly later tumulus that was recently excavated at the site of Pigi Artemidos (Late Bronze Age, unpublished data) contains ten burials, just as Tumulus 4 at Pigi Athinas did. However, the distribution of age at death is different, as at least one burial was that of a child. At the present state of analysis, the sample is also too small to assess inter-site variation in terms of burial customs and aspects of hierarchy. Still, these initial and tantalizing comparisons open a door to the possibility of varying expressions of perhaps locally diverse social structures and mortuary expression that emerged at this time in ancient Greece.

Conclusions

The bioarchaeological evidence at Pigi Athinas suggests apparent social inequalities between males and females that translated into differing expressions of biological stress and morbidity. Further, mortuary pattern evidence suggests that differential placement of burials reflected concepts of hierarchy and social asymmetry. A central grave founded the tumulus and to some extent probably defined kinship affiliations among the living and the dead. All of the deceased were organized around this central grave

that belonged to an old adult male. While males and females were equally represented throughout the tumuli, they were treated somewhat differently in death, as they were in life. The inferred differences between men and women in health and lifestyle suggested by the osteological evidence seem to have also manifested in the sphere of mortuary practices. These observations lead us to hypothesize that burial customs of this prehistoric society reflected relatively well-defined leadership roles of privileged males who were linked to a larger kin group and that probably an extended household was a central organizing feature of this society. The exclusion of children from the mortuary program at Pigi Athinas further defines a pattern of difference or exclusion that was expressed on a horizontal, age-related axis rather than in a vertical form of hierarchy.

At this transitional phase of prehistory, when differences between the two sexes in burial treatment also appear to be more pronounced than in earlier time periods, the grouping of burials in tumuli likely emphasizes lineage-group identity and new social roles. This structural attribute was widely developed during the latest phase of Bronze Age, which in southern Pieria is represented by the postdated "Mycenaeanized" funerary assemblages at Spathes and Treis Elies. At the present, the bioarchaeological evidence does not indicate any more specialized, status-linked behavior(s) among individuals buried in the prehistoric cemetery at Pigi Athinas.

The discovery of several cemeteries containing tumuli at the region of East Macedonian Olympus suggests the presence of an important coastal network of sites at the beginning of the Late Bronze Age. Future analysis of larger samples and biomolecular and biochemical research will allow further investigation and development of these preliminary observations and the questions posed here involving health, the organizational principles of burial customs, and the emergence of hierarchical social structures that unfolded in southern Pieria during the Greek Bronze Age.

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Notes

1. Detailed information on the archaeology and history of the region of Pieria and Macedonian Olympus can be found http://www.olympusarchaeology.gr/.

2. The terms Early, Middle, and Late Bronze Age are adopted for northern Greece, while the terms Early, Middle, and Late Helladic are used for the southern and central Greek mainland. For the chronological framework of the Bronze Age in northern Greece see Andreou et al. (1996, 2001). The chronology used here for the Middle Helladic and the beginning of Late Helladic period was taken from Voutsaki et al. (2009).

3. Shovel shaped incisors—skeleton T4(1) (Hillson 1996; Scott and Turner 1997), double condylar facets of the atlas—skeletons T1(1) and T4(4) (Saunders 1978; Finnegan 1978), and vastus notch—skeleton T4(1) (Finnegan 1978).

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10

A Hierarchy of Values

The Bioarchaeology of Order, Complexity, Health, and Trauma at Harappa

GWEN ROBBINS SCHUG

The Indus civilization flourished in northwest India and Pakistan in the third millennium BC as part of a vast Middle Asian interaction sphere that stretched across the Persian Gulf region. The height of the urban phase (2200–1900 BCE) is typically characterized by large, well-planned urban centers that exercised economic and cultural influence over hundreds of villages and cities across one to two million square kilometers of territory. The urban centers are characterized by a sense of organization, communication, and bureaucracy that featured 1) consistently planned cities enclosed by gated walls; 2) monumental architecture and unprecedented public and private sanitation facilities; 3) standardized construction practices, weights, and measures; and 4) pervasive use of the standardized symbols, signs, seals, and a still-undeciphered writing system. Regional variations existed in patterns of production, consumption, exchange, artifact styles, technologies, mortuary behavior, and specific elements of subsistence practices. However, the consistency of cultural features across this large territory combined with a focus on analogies to the social of complexity of West Asia led mid-twentieth-century archaeologists to the interpretation that a centralized, large-scale hierarchical authority regulated commerce and communication during the mature Harappan period. Upon further investigation and new theoretical developments in the field of anthropology, the lack of evidence of warfare or violent territorial expansion led to contrasting interpretations that higher-level organization in the Indus civilization was limited, weakly exercised, and consensually derived.

In this chapter, I examine these two competing models of Indus social organization through an examination of evidence of "exclusion" at the site of Harappa, one of the largest urban centers in the Indus civilization. The argument presented here is based on Crumley's (1995) assertion that inferences about hierarchy must be rooted in an internal analysis of the archaeological record and a demonstration of exclusion, which was considered an emergent feature of vertically ranked societies. Paleopathological data from 30 years of research at Harappa and the mortuary evidence from three burial areas in the city indicate that exclusion, differential access to basic resources, and structural violence were part of the Indus social experience and were strong forces in the formation, organization, and operation of this Indus society. In addition, these data reveal important insights into the social relations of leprosy in the Indus Age. The mortuary treatment of people with leprosy suggests that while the disease was recognized in the urban period, the roots of "othering"—the construction of difference—are found in the post-urban period. The appearance of so-called deviant burials and the different treatment for people with leprosy suggest that several different kinds of "others" emerged in this period of dramatic social change. Indeed, the archaeological record at Harappa may provide the earliest evidence concerning the origin of stigma and a trajectory of marginalization in South Asian prehistory.

Background: An Absence of Evidence of Indus Social Organization?

Archaeologists once characterized Indus society as an authoritarian empire (Piggott 1950; Wheeler 1953). Forged in an orientalist crucible, this view was largely based on West Asian analogies and "casual observations" of the archaeological record (Dhavalikar 2002, page). The Wheeler-Piggot paradigm also derived from the prevailing typological, nomothetic anthropological approach to social organization at that time, which assumed a uniform sequence of social evolution as ranked societies gave way to stratified social systems from which state-level societies emerged (Fried 1967). Because research on complex societies was increasingly overburdened by considerations of hierarchy as the primary organizing principle, the concept of heterarchy emerged as an alternative framework (Crumley 1979, 1995). Nonlinear systems theory, which initially derived from research on neural networks (McCulloch 1945), redefined complexity as the collective behavior of interacting units (Coveney and Highfield 1996). According to this model, complex societies develop from relationships among unranked

elements or from elements that are ranked in a variety of ways (Gold 2004). Using the principle of emergence, archaeologists can trace social relations through the simultaneous study of three constituent parts of the model—integration, communication, and the effect of history or initial conditions (Crumley 2005)—bearing in mind that agency, idiosyncrasy, chaos, historical contingency, and surprise are also contained in the interactions that determined behavioral and physical outcomes (Crumley 2001, 2005).

The concept of heterarchy was reasonably argued to explain the origin and functioning of small-scale societies, in which relationships between elements in small communities can change within a short time frame of weeks or months, leadership may cycle, and there may be no widespread desire to create formal institutional structures (e.g., Kirch 1989; Renfrew and Cherry 1986; Rogers 1995). It was also reasonably applied to large, urban Bronze and Iron Age societies in northeast Thailand, where there was no evidence of permanent rank (Higham 1989; O'Reilly 2000; White 1995). Importantly, these large settlements at Non Nok Tha, Ban Lum Khao, and Ban Chiang were not considered regional centers and no satellite communities were associated with them. Evidence of extensive weaponry, warfare, fortifications, or destruction events was also absent at these sites (Higham 1989).

A heterarchical model was eventually also applied to the Indus civilization, which was envisioned as a large-scale complex society without "a state bureaucracy or other 'trappings' of stateness" (Possehl 2002, 6). In this model, political and religious authority was collectively assigned, governance was shared among councils or craft guilds—a "first among equals" model—and any centralized authority exerted its will only weakly (Possehl 1990, 1998, 2002). Integration was achieved ideologically through shared cultural values: "nihilism,"[1] urbanism, technological innovation, and concern for and the use of symbolism around water and its management (Possehl 2002). The Indus civilization has since been portrayed as a rare example of a large, complex society that formed in the absence of hierarchical social structure, state-sanctioned use of force, or structural violence (e.g., McIntosh 2002).

However, a heterarchical model may not map neatly onto archaeological evidence from Indus cities, which demonstrate some features consistent with hierarchical social organization (Potter and King 1995). Urbanization occurred rapidly with an influx of immigrants from rural areas, hinterlands, and disparate states as people were attracted to the city by an opportunity to participate in the specialized craft production and exchange that oc-

curred in urban areas. Subsistence and other economic activities in urban centers were largely supported by relationships with satellite communities, rural farmers, and itinerant herdsmen. There is archaeological evidence of inequality in the circulation of material goods within Indus cities. In some respects, urban communities in the Indus territory were defined as central places without regard to local availability of resources necessary for a large exchange economy and without regard for aspects of landscape variation.

A close reading of the spectrum of opinions on Indus social organization leads to the observation that the crux of this debate is about exclusion in Indus society. A hierarchical society is, by definition, a diverse society but one based on inequality. This should emerge from the archaeological record in the form of exclusion (Crumley 1995), or "unequal access to goods, information, decision-making, and power" (Price and Feinman 2010). The Indus civilization was undoubtedly complex and ordered (Possehl 2002, 55–56). The archaeological record clearly demonstrates heterogeneity and social differentiation in settlement patterning, mortuary treatment, isotopic variation, and the circulation of material culture (Kenoyer 1997a; Kenoyer et al. 2013; Wright 2010). However, clear and specific physical evidence of exclusion or inequality as expressed by clear differences in access to basic resources had not previously emerged from the archaeological record of Indus cities.

Thus, all of the arguments for particular forms of social organization—hierarchical or heterarchical—in the Indus civilization have been based on an absence of evidence (Cork 2005, 2011). Scholars who agree that the Indus civilization is the earliest example of state formation in South Asian prehistory (e.g., Kenoyer 1991, 1997b) have seen their case for statehood weakened by the apparent absence of conclusive evidence of exclusion in the archaeological record of Indus cities. In an ironically similar way, scholars who claim that the Indus civilization was a "peaceful," heterarchical society that lacked social stratification also base their claim on an absence of archaeological evidence of exclusion (Possehl 2002, 57).

Part of the difficulty is the way the problem was initially framed. Mesopotamia and Egypt, to a lesser extent, were used as comparative models that defined what institutionalized state power "should look like" in the third millennium BC. In the case of Mesopotamia, hierarchical social organization is demonstrated archaeologically and textually by monumental architecture, central control over access to resources, state-sanctioned violence, exclusion, social classes, and mechanisms of social control. The Indus civilization lacks such evidence. While monumental architecture and

city walls exist, there is no clear evidence of palaces or temples. There is evidence of structured distribution of material culture but no clear ostentatious displays of wealth. There are artifacts that would be interpreted as weapons in a different context, but there is no archaeological evidence of warfare or material signs of social control in Indus cities. In West Asia, textual evidence supports the inference of hierarchy. Indus script has yet to be deciphered but it appears to be focused on commercial or ritual concerns. As Indus script occurs in such short phrases, it might never speak to questions of social structure.

Aside from the inherent fallacy of relying on an absence of evidence, it is also unclear why we should expect a highly generalized, externally derived model to be a good analogical fit for the Indus civilization. Inferences about social relations should be based on an internal analysis of the evidence (Morrison 1994). If exclusion was a feature of the Indus social experience, it should emerge from the archaeological record. Meaningful interpretations of social relations are often generated from integrating mortuary archaeology and paleopathological analysis (Joyce 2005; Meskell 2000; Rakita et al. 2005; this volume), but Indus mortuary practices have lacked previous systematic study. Furthermore, embodiment theory suggests that lifelong inequality may be evidenced in human skeletal remains (Blakey 2004; Kreiger 1994; Scheper-Hughes and Lock 1987), yet the skeletal assemblages from most Indus cities had not (until recently) been considered a source of knowledge regarding questions of power, exclusion, inequality, and structural violence. This chapter will address the question of whether exclusion was a feature of Indus society and what it means for understanding social relations through time in this Indus city.

Materials and Methods

Harappa is located on the southern bank of the Ravi river, a tributary of the Indus river (Fig. 10.1). The city began at its northern extent, on mound F, around 3300 BC. Initially it was a relatively small settlement, but by the mature phase, period IIIC (2200–1900 BC), the city had expanded southward to include large residential and administrative centers at mounds AB and E (Fig. 10.2). During this period, the city's population grew to approximately 22,000 to 30,000 people. Since 1926, 265 individuals have been excavated from three mortuary contexts at Harappa. This chapter includes a description of the mortuary context following a summary of the bioarchaeological data for 207 of these individuals: 115 individuals from pre-1947[2] exca-

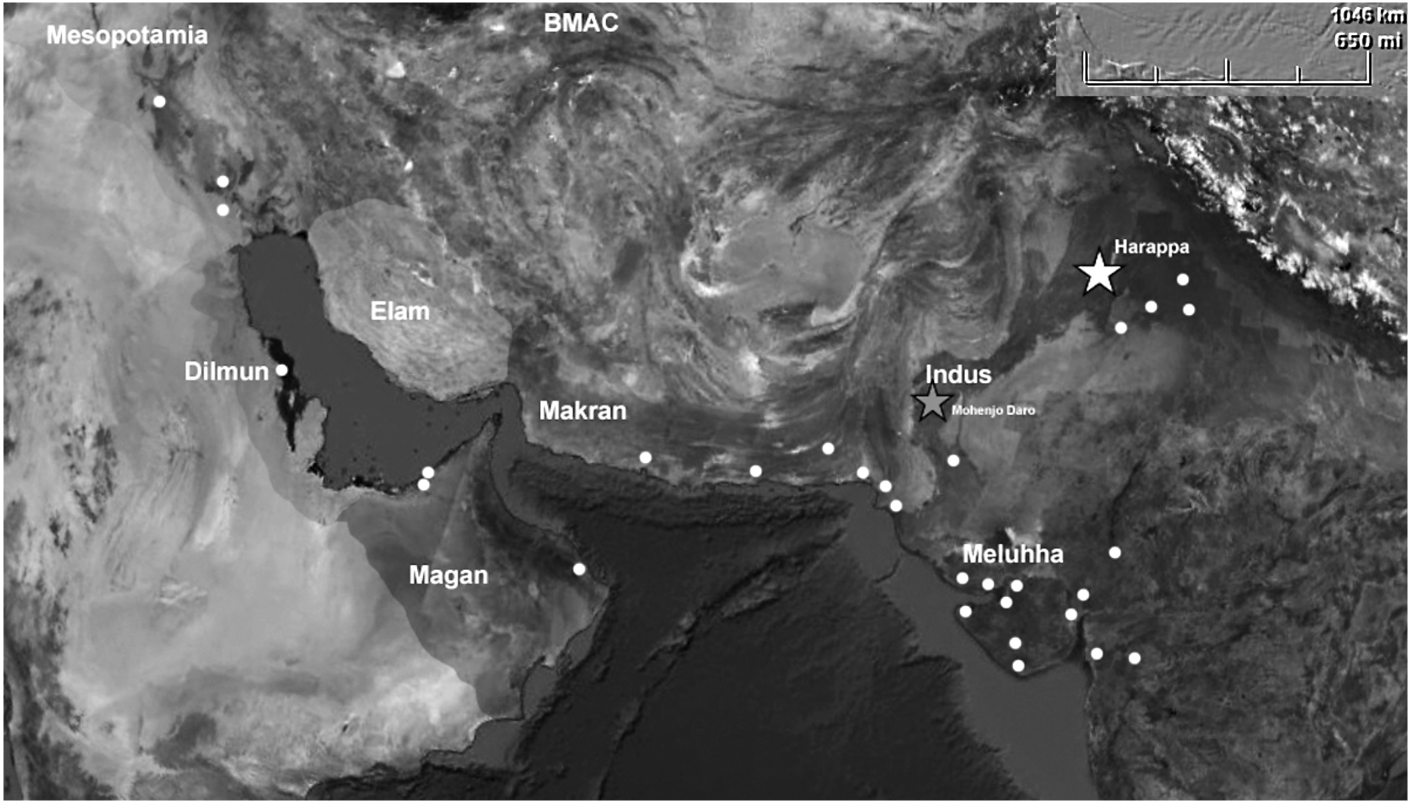

Figure 10.1. Map of the Third Millennium Middle Asian Interaction Sphere, the geographic extent of the Indus civilization, and the location of the city of Harappa. Map by G. Robbins Schug.

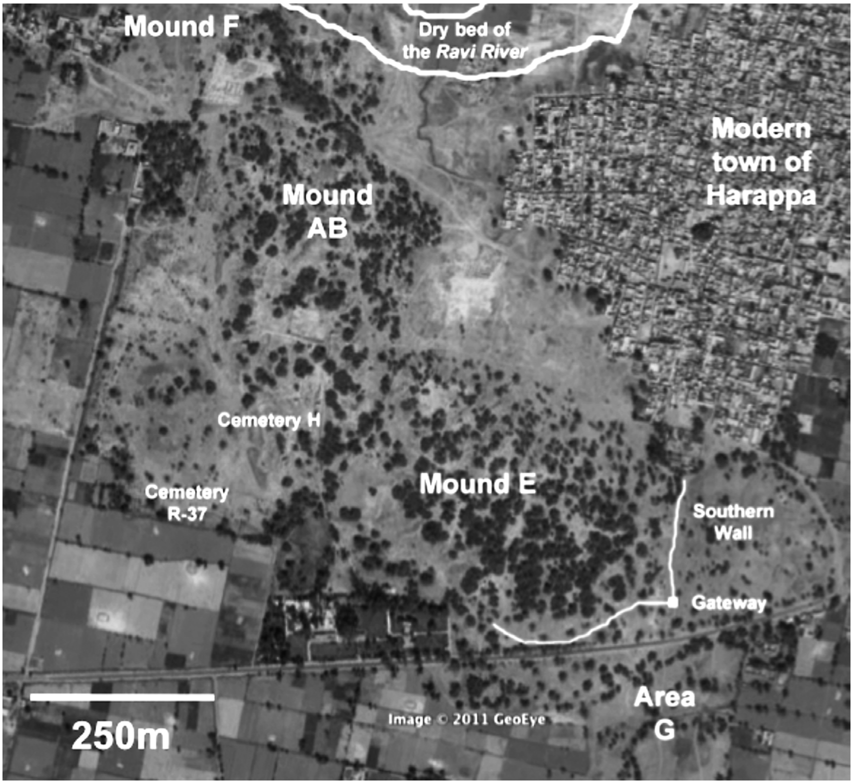

Figure 10.2. Aerial view of the archaeological site of Harappa.

vations at cemetery R-37, cemetery H, and Area G examined by Robbins Schug[3]; one individual from Mughal's 1968 excavation; and 91 individuals excavated from Cemetery R-37 in 1987–1988 by the Harappa Project of the University of California, Berkeley.

Robbins Schug estimated sex relying primarily on cranial variation (following standards in Buikstra and Ubelaker 1994); pelvic elements were unavailable or poorly preserved. Age was estimated using cranial suture stenosis (Meindle and Lovejoy 1985) and dental wear (Lovejoy 1985). Nancy C. Lovell estimated sex using pelvic and cranial morphology (Buikstra and Ubelaker 1994). Age was estimated using pubic symphysis and auricular surface morphology (Lovejoy et al. 1985) when possible, cranial suture closure and dental wear in cases where os coxae were not available or were not well preserved. Following Lovell (2014b), the individuals are categorized here as young adult (20–30 years old), middle adult (31–40 years old), and older adult (41+ years old). Sexing of subadults was not attempted, but Robbins Schug estimated age for immature skeletons based on dental develop-

Table 10.1. Age and sex of skeletons from Harappa

	N total	N examined	Sub-adult	YA (18–34)		MA (35–54)		OA (55+)		Indet. adult
				M	F	M	F	M	F	
Cemetery R-37	108	66	3	3	9	2	3	7	3	31
Cemetery H										
Stratum II	26	26	6	0	4	0	2	0	1	13
Stratum I[a]	78	45	15	0	5	0	2	3	1	19
Area G	23	23	9	1	2	3	2	1	0	5
Total	235	160	33	4	20	5	9	11	5	68

[a]The pathological profile of this cemetery was documented but these results will be reported elsewhere.

ment, dental eruption status, and epiphyseal fusion (Scheuer 2000). Demographic characteristics for the combined sample are provided in Table 10.1.

Robbins Schug and Lovell examined the skeletal remains for evidence of direct and indirect trauma, including fractures, dislocations, hematoma, callous formation, and other signs of healing (Lovell 1997, 2008). Both investigators recorded pathological lesions based on visual observations of the human skeletal remains using standard methods for describing and diagnosing proliferative, lytic, and deformational lesions by comparing their presence and patterning with expectations from clinical literature (e.g., Resnick 2002). It was not always possible to examine the patterning of lesions beyond one or two skeletal elements for fragmentary and incomplete individuals. Diagnosis was limited in such cases to general categories such as "periosteal reaction" or "maxillary infection," rather than specific diagnoses such as leprosy, for example. In cases where evidence of infection was associated with trauma, Robbins Schug and Lovell erred on the side of caution, attributing these lesions to broad categories such as "inflammation" or "infection." Based on the presence of leprosy at an Indus outpost in Rajasthan by 2000 BC (Robbins et al. 2009), in the case of complete crania, splanchnocranial remains, and/or postcrania, the possibility of infectious diseases such as leprosy and tuberculosis was evaluated based on diagnostic criteria described previously (Robbins Schug et al. 2013).

Results

The Mortuary Domain

The mortuary data from Harappa were compiled from excavation reports, which detail the location, orientation, positioning, posture, and grave goods for each excavated burial from the pre-partition era (Dales 1991; Dutta 1975; Gupta et al. 1962; Sastri 1965; Vats 1926–1927; 1927–1928; 1929–1930; 1930–1934a, 1930–1934b, 1930–1934c, 1930–1934d; 1940; Wheeler 1953). Detailed excavation reports for the Berkeley Harappa Project remain unpublished. The observations about mortuary behavior in Cemetery R-37 presented in this chapter can be tested against those data when they become available.

Cemetery R-37, which was in use from roughly 2550 to 2030 BC (Kenoyer et al. 2013), has received the most research attention of all the burial areas at Harappa. This cemetery is located south of Mound AB, a principal settlement area at Harappa in the urban period. K. N. Sastri and H. K. Bose began four excavation seasons here in 1937–1938, Sir Mortimer Wheeler excavated here in 1946, M. R. Mughal in 1968, and the UC Berkeley project chose this cemetery for further investigation in 1987–1988 (Mughal 1968; Wheeler 1953; Vats 1940). In total, 209 burials were excavated.

The majority of the graves were oriented north-south and bodies were arranged an extended, supine posture. Three wooden coffins that were traced by an outline in the soil were documented, but most individuals were laid directly in the graves, which crosscut one another over time. Graves were 10 to 15 feet in length and 2.5 to 10 feet wide, depending upon the number of individuals and the number of ceramic items included. The ceramics were typical household forms and the majority of graves had between 15 and 20 (the range was 2–40) items. Ceramics were placed at the head and/or the feet or (less commonly) were arranged around the rest of the body. Occasionally, the ceramics were buried such that the body was level with the openings of the vessels. In the early phase of cemetery use, ceramics were painted; later vessels were unslipped and unpainted. Personal ornaments among female[4] burials included a truncated cylindrical amulet worn at the throat, a copper ring, three black stone amulets, and shell bangles worn on the left arm of female skeletons. Beads were recovered from both male and female burials, but males had fewer ornaments. Cosmetic items included antimony, bronze- and copper-handled mirrors, mother-of-pearl shells, and shell objects such as spoons.

Cemetery H and Area G were both in use during the post-urban period, after 2000 BC Cemetery H represents a northern extension of R-37. There were two phases of burial activity—stratum I corresponded to the Chalcolithic period (1700–1300 BC)[5] and stratum II was in use during the post-urban period (1900–1700 BC). Two different mortuary behaviors are represented in stratum II. On the eastern side were primary interments of single individuals, lying in an east-west or northeast-southwest orientation, usually in an extended supine posture, although legs were flexed for a few individuals (Vats 1940). Burials in the western half of this stratum were fragmented and incomplete; these are conventionally referred to as fractional burials. As with R-37, cemetery H mortuary ceramics were utilitarian items, but they were generally fewer in number. The finishing and decorative motifs differed between the two cemeteries.

Area G contrasts with the other burial areas at Harappa. This ossuary is located in a low-lying field southeast of the city wall that surrounds Mound E. Vats (1940) was interested in the lifestyles and behavior of people who lived "outside the gate," or the non-elite people or those who might not be full members of Harappan society. Thus, Vats excavated a 140-foot trench north to south through what he defined as the core of this area. This test excavation revealed a well at the far southern end. At the northern end, some "poorly constructed" architectural remains, cylindrical and unicorn seals, terracotta figures, ceramics, and the ossuary were found. The osseous remains (1.3 to 1.5 meters below the surface) consisted of twenty isolated human crania, three human mandibles, a collection of human long bones, a scapula, and two partial vertebral columns, as well as a bovine cranium and a canine vertebral column in a scatter at the northern end of the deposit and one intact burial (G.289) located in the southeast corner of the excavated area that was oriented northwest to southeast (Vats 1940). In all, parts of 23 bodies were interred here (12 adults and 9 subadults). According to Vats, the human crania were placed in four distinct piles in the trench, but anthropologists later described these interments as "disarticulated" and "disorderly" (Gupta et al. 1962, 2).

The remains in Area G represent deviant burials. They were interred in an apparently disorganized manner, but isolated crania, articulated leg bones, and vertebral column indicate that decomposition occurred elsewhere. There was no sign of burning or charring, suggesting that these are not incompletely cremated individuals. The presence of other animals with the human remains is interesting in that the faunal remains are also isolated segments and not whole animals.

Figure 10.3. Evidence for a healed broken nose and a sharp blunt force traumatic injury at glabella on an adult male skull from Area G (Individual I.S.11). This individual also demonstrated proliferative and destructive lesions on the left frontal and left parietal bones.

Small pots (*lota*, or drinking vessels) were interspersed with the human remains in Area G, but in the layer just above the human remains there were a large number of unbroken offering dishes, goblets, and vases stacked and piled together in a manner reminiscent of the human remains below (Fig. 10.3). Excavation photographs suggest that 20 to 25 dishes were present (Vats 1940). The ceramic offerings resemble the human remains in the sense that they are not intentionally distributed among individual people as grave goods for an individual's journey to the afterworld but rather are piled as a collection of vessels for a collection of crania and other largely disassociated remains. No absolute dates are available for Area G as of yet, so the ossuary was dated using the ceramic typology. The styles were identified as belonging to a time intermediate between the Cemetery R-37 and Cemetery H cultures (i.e., circa 2000 BC).

Paleopathological Analysis

In Robbins Schug's sample of 115 Harappan skeletons, there were 17 adult males (14.8 percent), twenty-six adult females (22.6 percent), and 18 subadult individuals (15.7%) in three burial areas. Specific age and sex estimations were not possible for 54 individuals (46.9 percent), who were listed as "indeterminate" due to fragmentation, incompleteness, and poor preservation. Forty-two individuals (36.5 percent of the total individuals studied) had intact crania—eight immature individuals and 34 adults (16 males and 18 females). Lovell (2014a) examined 92 adult individuals from cemetery R-37, including 19 complete skeletons from primary contexts (10 females and 9 males, three with postcranial elements only), 69 adults from debris contexts (including nine isolated crania), and one adult recovered from cemetery R-37 by Mughal (1968). She evaluated 29 crania for evidence of trauma and pathology, bringing the total number of crania included here to 71 from all three mortuary assemblages.

Trauma

Cranial trauma consistent with interpersonal violence affected 7.5 percent (4/53) of the adult crania from the urban cemetery R-37. Three adult females (3/15, or 20 percent) and one adult male (1/16, or 6.3 percent)[6] had at least one depression fracture on the cranium. One of the affected females demonstrated evidence of recidivistic trauma. In addition to the healed depression fracture on the left occipital bone, she had a nearby possible ossified hematoma, a healed rib fracture, and a healing Colles' fracture of the right radius. The cranial traumata are interpreted as evidence of interpersonal violence, and considering the skewed sex ratio and the recidivist injuries on one female, it is possible that the risk of violent injury in the urban phase was gendered, with females at greater risk of violence. Nine individuals from the post-urban period demonstrated evidence of cranial trauma: three of eight individuals (37.5 percent) from Cemetery H (stratum II) and five of ten individuals (50 percent) from Area G.

The human skeletal sample from Harappa thus has the highest prevalence of interpersonal injury ever documented in a prehistoric South Asian population.[7] A total of 12 individuals (16.9 percent) demonstrated evidence of craniofacial trauma—including two immature individuals, seven adult females, and three adult males. The prevalence of injuries in the mortuary assemblage increased through time, from 7.5 percent of crania affected in the urban Cemetery R-37 to 44.4 percent of crania in the post-urban pe-

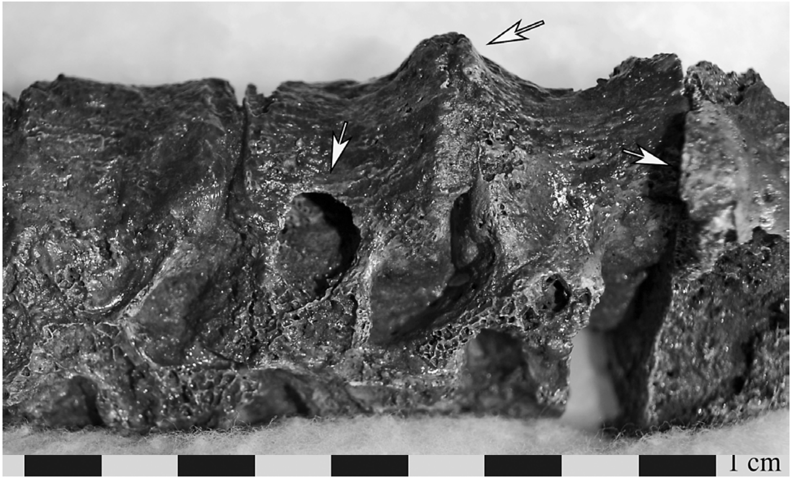

Figure 10.4. Lesions consistent with a diagnosis of tuberculosis included traces of psoas abscess formation on the right lateral surface of the tenth thoracic vertebra, associated reactive bone formation, and ankylosis on the adjacent elements (Individual H.710). This individual also had lesions on the cranial vault, the maxilla, the cervical vertebrae, the left ulna, the left femur, and the left tarsals and metatarsals. Photo by G. Robbins Schug.

riod, and adult females had the highest risk of injury. Children (approximately five years of age) were affected only in the Area G assemblage. The type of injuries also varied over time. Blunt force trauma to the cranial vault, inflicted with a club-like implement, was the primary type of injury at Harappa (11/12 affected crania, or 92.7 percent), but two male individuals from Area G had healed broken noses and one of these males also had a sharp force trauma injury at glabella (Fig. 10.4).

Biological Stress, Diet, and Disease

Dental health was examined for the pre-1947 assemblage (Kennedy 1980) and the post-1947 assemblage from R-37 (Lukacs 1992). Kennedy (1984; Lovell and Kennedy 1989) found a low prevalence of both enamel hypoplasia and dental caries for the pre-1947 skeletal material from R-37, cemetery H, and Area G. While Kennedy reported a low frequency of dental caries and abscesses in this sample, he described alveolar remodeling as “ubiquitous” (Lovell and Kennedy 1989, 90). Lukacs (1992) found a dental pathology profile at cemetery R-37 consistent with an agricultural diet. Enamel hypoplasia was present in 72.2 percent of the 36 individuals studied. Alveolar resorption affected 52.6 percent of a sample of 38 individuals. Other dental diseases included dental caries (affecting 43.6 percent of a sample of

39 individuals), calculus deposition (affecting 42.5 percent of a sample of 40 individuals), antemortem tooth loss (affecting 31.7 percent of a sample of 41 individuals), dental abscess (affecting 18.4 percent of a sample of 38 individuals), and exposure of the pulp chamber (affecting 17.1 percent of a sample of 41 individuals). The crude prevalence of dental caries was 6.8 percent of the total sample of teeth examined (including isolated teeth).

Sex differences were not significant except in the case of enamel hypoplasia, which showed strong sex difference—56 percent of males and 92 percent of females were affected (see Table 2 in Lukacs 1992, 138). Some individuals demonstrated extensive evidence of infection, alveolar resorption, abscess, and antemortem tooth loss. Individual H87/137/148a for example, accounted for 50 percent of the abscesses observed (six in the maxilla and five in the mandible). Dental caries primarily affected maxillary molars and 49 percent were advanced to the point where they had penetrated the pulp chamber. Tooth loss primarily affected the mandibular molars.

Other skeletal pathological lesions described at Harappa are consistent with anemia (Kennedy 1984; Lovell 1994, 2014b), degenerative joint disease (Lovell 1994, 2014b), congenital disorders (Kennedy et al. 1993), inflammation (Lovell 2014b; Robbins Schug et al. 2013), and other signs of infectious disease (Robbins Schug et al. 2013). In an examination of a sample of the combined skeletal assemblages from Mohenjo Daro and Harappa (pre-1947 samples from R-37, H, and Area G), Kennedy found that vertebral osteophytosis was relatively rare. Porotic hyperostosis was unexpectedly common (present in 25 percent of individuals), particularly at Mohenjo Daro (Lovell and Kennedy 1989). Lovell reported an opposite situation in the post-1947 assemblage from R-37. Only one case of possible porotic hyperostosis and one case of possible cribra orbitalia were documented there, while degenerative joint disease was the most common condition in these remains. Marginal lipping affected approximately one-third of the vertebral bodies examined. Of the rest of the skeleton, degenerative joint disease most commonly affected the knee (31 percent), followed by the wrist (15 percent) and the ankle (12 percent). Evidence of congenital defects included one individual from cemetery R-37 who exhibited partial sacralization of the fifth lumbar vertebra and one individual with scaphocephaly (Kennedy et al. 1993).

Robbins Schug examined 66 individuals and Lovell examined 84 individuals (19 complete skeletons) for evidence of infection. Lovell found little evidence of infection in the pre-1947 assemblage; she found only one

individual with a local infection secondary to an injury on a pedal phalanx and five individuals with evidence of periosteal inflammation on the tibia and fibula. These two investigators reported evidence of maxillary sinus infection in one individual (1 of 150, or 0.7 percent affected), of chronic periosteal inflammation on at least one long bone from five individuals (3.3 percent of tibiae and fibulae affected), and two individuals with a pattern of lesions consistent with the diagnosis of leprosy (1.3 percent affected). In the 26 post-urban phase burials studied from Cemetery H (Stratum II), there is evidence of nonspecific periosteal reaction (3.9 percent affected), maxillary infection (7.7 percent affected), lesions consistent with leprosy (7.7 percent affected), and tuberculosis (7.7 percent affected) (Fig.10.5). Of

Figure 10.5. Severe rhinomaxillary infection consistent with a diagnosis of leprosy occurred in a large number of individuals at the Harappa site. These lesions included resorption of the anterior nasal spine, changes to the anterior nasal margin, remodeling of the nasal septum, exposure of the neurovascular channel inside the pyriform aperture, resorption of the dental alveoli of the anterior dentition up to the level of the nasopalatine nerve, porosity along the margin and remodeling of the pyriform aperture, porosity on the bony palate, the zygoma, and the nasal and orbital processes of the maxilla (Individual 306a). Photo by G. Robbins Schug.

Figure 10.6. The ceramic assemblage buried in a layer above the human remains at Area G, Harappa.

the 23 individuals from Area G, there is evidence of nonspecific infection or inflammation (8.7 percent affected), maxillary infection (4.4 percent affected), and lesions consistent with leprosy (21.7 percent of individuals affected) (Fig. 10.6). Thus, the prevalence of infection increases from 5.3 percent (eight individuals) affected in the urban phase to 30.6 percent affected (15 individuals) in the post-urban phase. Of note, however, is the fact that this pattern may be due to the fragmented nature of the skeletal collection from Harappa, as many individuals are poorly preserved. Given better preservation, more individuals might in fact have been diagnosed with infectious diseases.

The to summarize these results: 1) females were most affected by developmental disruptions in childhood, as measured by the crude prevalence of enamel hypoplasia; 2) porotic hyperostosis was common in the skeletal sample from Mohenjo Daro but much less common in the Harappan skeletons; 3) there was a low crude prevalence of cranial trauma in the urban period, which was elevated to a high rate in the post-urban period; 4) leprosy was present at Harappa in the urban phase (2500–2000 BC) but evidence of tuberculosis was found only in the post-urban phase; 5) infection and traumatic injuries were almost non-existent in the urban period, and relatively speaking, the risk for both was significantly elevated in the post-urban period; 6) adult females had a higher prevalence of traumatic injuries, infection, and infectious diseases; and 7) the highest crude preva-

lence of individuals affected by infection, infectious disease, and injuries was observed in the immature and adult skeletal sample from Area G.

Discussion

Exclusionary Mortuary Behavior

Area G presents clear evidence of exclusion from the city cemeteries. However, the co-occurrence of exclusion, infection, and interpersonal violence make for a more complex interpretive scenario and raises the question of whether people in the Area G sample were excluded from the city cemeteries because they had highly visible and often stigmatized infections. Or was exclusion a function of pre-existing social differences that more fundamentally predisposed these people to trauma and infections? An examination of the social relations of leprosy, inequality, and exclusion requires a deeper look at the archaeological record of mortuary behavior. If we can establish a range of variation in ritual and funerary practice, the presence of non-normative burials and the treatment of people with traumatic injuries and leprosy may help us gain insight into the factors associated with exclusion at Harappa.

Two skeletons from Cemetery R-37 had lesions consistent with leprosy (779c and 820) and/or skeletal trauma (796b and 820). All four were buried in common (or shared) graves. Of the hundreds of graves excavated, multiple individuals shared five graves. Of these, three of them contained an individual who had been affected by leprosy or trauma. Other than sharing the grave with other adults and immature individuals, individuals with leprosy were buried in the prevailing orientation, posture, and style. Conversely, the single burials and the fractional burials excavated in Cemetery R-37 contained skeletons with no evidence of trauma or infectious disease.

In cemetery H, two individuals demonstrated lesions consistent with a diagnosis of leprosy (H.488 and H.696). H.488 also had a circular depression fracture of the frontal bone that was in an advanced stage of healing (described in Robbins Schug et al. 2012). Both of these graves were also laid out in the prevailing northeast-southwest orientation. They were buried in an extended supine posture with arms parallel to the body (Vats 1940, 221–222, Plate LIa and LIf). Both skeletons were accompanied by one or two small *kalasa*[8] (or "water pots," the most common ceramic form in the cemetery H graves). Burial orientation, posture, and grave goods for these two burials do not differ significantly from the graves of unaffected indi-

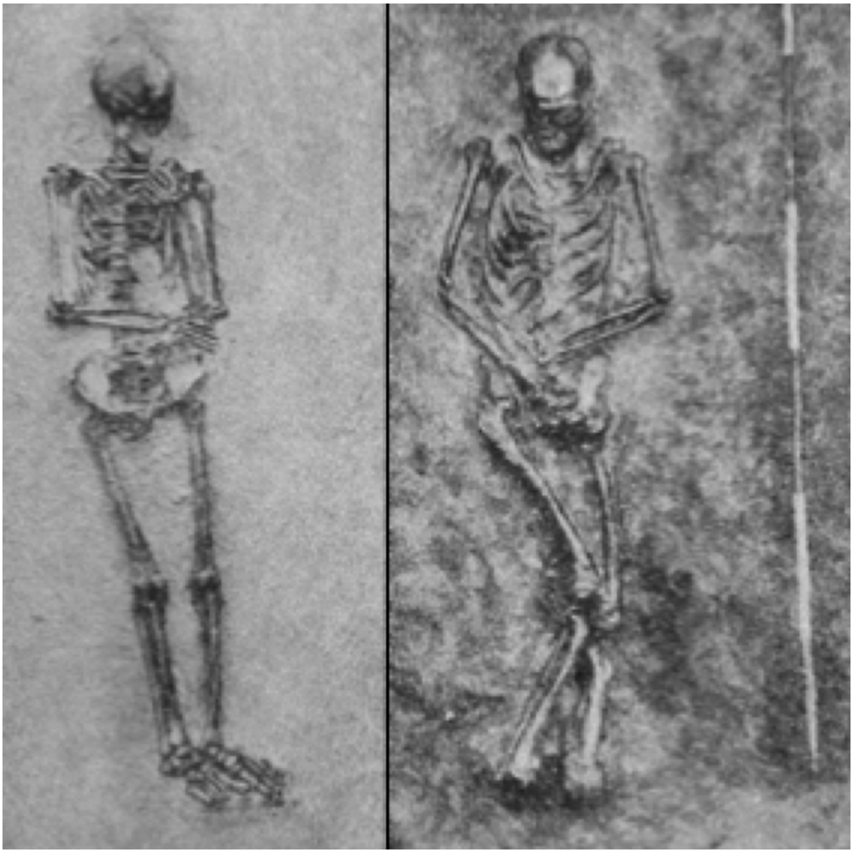

Figure 10.7. Two burials from the western portion of Cemetery H, Stratum II. The skeleton on the right was affected by leprosy. Both affected individuals were buried missing foot bones. All of the other interments in this mortuary population had their feet.

viduals in Cemetery H. The only major difference in these two burials is that both individuals were missing foot bones (hand bones were intact) (Fig. 10.7).

It appears from these data that leprosy and, to a lesser extent, traumatic injuries were recognized in the mortuary rituals conducted at Harappa. In the urban period, people with leprosy were buried in shared graves rather than in single interments. In the post-urban period, people with leprosy were buried singly, but the feet may have been intentionally removed from the burials prior to interment. Further research, including excavation in the post-urban burial areas, will be required to address the question of why the feet were removed. Additional research should consider whether this was done to facilitate the journey to the next world, to prepare the dead as

a proper sacrifice to the gods, or as a means of protecting the living community from those who had died a "bad death." Leprosy was recognized and marked as different, but people with leprosy were not excluded simply for having the disease. Everything else about the cemetery burials of people with leprosy was within the range of variation for unaffected individuals. The people at Area G were excluded from the cemetery for some other reason such as dimensions of their behavior, personal, or community identity.

Health, Death, and Exclusion

The bioarchaeological evidence supports my assertion that this community practiced various and perhaps sometimes subtle forms of exclusion resulting from an expression of hegemonic power. Exclusion is an emergent feature that is required for a society to be considered hierarchical, and the violent expression of power and exclusion is anathema to the concept of shared governance by equals, as Possehl had suggested. It is difficult to interpret this assemblage beyond these basic observations because it was excavated almost a century ago. The sample has suffered postmortem alteration and damage in storage, but even so, it is unique in Indian archaeology. It is my contention that this evidence of violence, disease, and mortuary behavior at Harappa suggests a pathway to important new insights on the Indus civilization. Planned research designed to test these hypotheses using archaeological and bioarchaeological approaches is revitalizing the study of Indus archaeology, which has stagnated for decades because of unscientific rehashing of old data to support conflicting views of the past and an unjustifiable willingness to rely on the absence of evidence as a basis for argument.

Bioarchaeologists seek to differentiate social processes, such as state-sanctioned violence, homicide, genocide, feuding, warfare, and other forms of intragroup and intergroup violence (Roksandic 2006) from the paleopathological record and mortuary archaeology. This is a very difficult task given the nature of the archaeological record, particularly at a site that was excavated twenty-six times in the twentieth century. The 1931–1947 excavation reports used here describe archaeological work that was conducted prior to the development of middle-range theory, an understanding of taphonomy, or site formation processes, and caution is warranted. Even in the best of circumstances, the dead are not representative of a living population. The excavation reports also clearly demonstrate the selective curation and the deterioration of the available skeletal material over time in the Anthropological Survey of India's storage facility at the Indian Museum in

Kolkata. However, the combined evidence from mortuary treatment and paleopathology leads to some broad inferences about exclusion and vulnerability in this important and paramount Indus city.

The mortuary and bioarchaeological data from Harappa suggest strong social differentiation among burial communities at Harappa. Traumatic injuries, infection, and disease were present at a low frequency in the urban-period cemetery R-37. As changes in climate and social and economic changes brought about massive population movements, social and sanitation problems, and a reorganization of the social world in the post-urban (or Late Harappan) period, evidence of rates of violence and infection increased in the post-urban cemetery. Biocultural stress levels were significantly elevated at this time relative to the urban period, and the evidence from Area G strongly indicates that Harappan burial communities unevenly affected. This community demonstrated the highest and most unequal level of vulnerability to violence and disease.

To return to the question of hierarchy—defined here as a diverse society in which some members are formally excluded or subordinate to others, as evidenced by emergent behaviors—the human skeletal remains demonstrate clear differences among groups in access to resources, risk of violence, and infection. This is consistent with expectations for hierarchical societies. To view these data as supporting an alternative, heterarchical model of Indus society would require much stretching and twisting of the evidence. Prior research on the subject of Indus social organization has been primarily based on externally derived expectations of what hierarchy "looks like" in the archaeological record. Although there may be an absence of evidence of highly ranked rulers in the architectural features or the mortuary practices and although the artifactual evidence has been twisted to fit both models, new data from paleopathology and mortuary archaeology clearly indicate inequality and exclusion.

The mortuary behavior at Harappa also suggests the initial emergence of "othering"—the construction of difference—for people with leprosy over time. People with leprosy were not necessarily excluded from the cemetery, and their burial orientation, posture, and grave goods were not significantly outside the range of variation for unaffected individuals. Their treatment may even suggest that they were given special care, such as including their bodies in shared graves (in R-37) or the possible perimortem removal of the feet (in the post-urban period). However, leprosy was marked as different, which is often the first step in the process of othering and can eventually lead to stigmatization. It is interesting to note that at the one other Indus

site where leprosy has thus far been discovered, Balathal, that individual was interred within a meters-high deposit of vitrified cow dung (Robbins et al. 2009). For the past several millennia In South Asia, Vedic tradition has held the excrement of cows to be the most venerated and ritually pure substance on Earth. Fire is the medium of transformation of the ritually impure (dead bodies, for example) to a substance that can serve as a proper sacrifice to the gods. It is possible that the Balathal interment in burned cow dung represented an attempt to ritually purify the body in death. If this hypothesis can be supported by additional evidence from other Indus towns, it indicates concern that people with leprosy receive special treatment to prepare them upon their deaths.

Conclusions

Appadurai (1988) has argued that the perception of Indians as hierarchical is part of their incarceration as "natives" through a process of totalizing, essentializing, exoticizing, and Orientalizing the "other." This chapter is not intended to support the notion that South Asians are essentially, deeply, or naturally hierarchical or despotic (Morrison 1994). It is not about the origin or evolution or the why, when, or how of hierarchy in South Asia. Hierarchy is not a total social fact that reveals the power of a social structure (Mauss 1966). That view would ignore human agency, resistance, and the potential impact of individuals or historical contingency. Rather, the social world and its institutions are constituted and reconstituted through individual actions (Anderson 1991; Bourdieu 1977), although material conditions and external forces still influence and constrain this practice (Anderson 1991; Isbell 2000). The nature of sociocultural change in the past is expressed in symbolic changes. These "material vehicles of thought" allow us to uncover the meaningful structure of experience (Throop 2009). While archaeology may not reveal the "supposed inner state of an actor" (Husserl 1962), mortuary symbolism and the body as a sign can demonstrate something about the social relations between those actors and their situations (Geertz 1973, 110).

My goal is to understand Indus social experiences based on the evidence from Indus cities instead of shoe-horning data to fit preexisting Western theoretical constructs. Without assuming that Asian states are hierarchical or heterarchical, this chapter sought an internal analysis of social relations by asking what the data from the human skeletal remains tell us about social organization, differentiation, exclusion, access to basic resources, and

vulnerability. Some of these differences may have been gendered, as indicated by the inferred childhood health status of girls and as seen in enamel hypoplasia patterning and the fact that traumatic injuries, infection, and infectious diseases were most common among women. It is becoming clear that some of the males buried in cemetery R-37 at Harappa were immigrants, possibly from Mesopotamian cities (Kenoyer et al. 2013), but these data suggest that other considerations informed the disposition of human remains, not just a person's natal origin or consanguinal relationships. The perceived spatial patterning of pathological conditions between cemeteries independently makes an argument for exclusion, or a broader construction of difference: the highest crude prevalence of individuals affected by infection, infectious disease, and injuries was observed in Area G.

The bioarchaeological and mortuary evidence presented in this chapter helps us reassess the mantra that the Indus civilization was a rare, peaceful urban society without strong social divisions or evidence of exclusion. Instead, these data support the suggestion that aspects of personhood—identity, community membership, occupation, social class, behavior, and compliance with or resistance to norms—were the most salient forces that shaped vulnerability and access to basic resources in life and treatment and representation in death.

These data also reveal an important new insight into the social relations of leprosy. Although leprosy is a strongly stigmatized disease in South Asia today—seen as the ultimate embodiment of spiritual corruption and pollution—sufferers of the disease were apparently not excluded or negatively marked by difference among the dead at Harappa. In some respects, mortuary specialists treated people with leprosy as they would any other burial. As the prevalence of the disease increased in the post-urban period, differences were more strongly marked, but leprosy became a basis for distinction, not necessarily exclusion. This, in and of itself, has profound implications for understanding the construction of difference in times of social stress, the history of "otherness" for people with leprosy, and the eventual development of stigma of this disease in South Asia.

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Notes

1. In this context, nihilism was used to indicate a willingness to break with past traditions, many of which were abandoned along with Indus cities in the second millennium.

2. India and Pakistan were partitioned in 1947. This affected the location of the remains and the history of analysis.

3. I examined an additional 45 individuals from the post-urban period V in Cemetery H (1700–1300 BC), but those remains are not directly relevant to the question of Indus social organization, inequality, and exclusion because they were buried long after the urban society ended. Those remains are not included in this study.

4. Bioarchaeologists on site during the 1987–1988 excavations estimated sex in situ, and thus this observation is trustworthy.

5. Stratum I interments were in funerary jars. Deceased individuals who had decomposed elsewhere and some of whom demonstrate evidence of burning from cremation were gathered and their remains placed in these jars. This chapter excludes data on the 45 individuals recovered from this stratum, as these burials took place hundreds of years later in time and cannot speak to the question of hierarchy or social relations in the Indus civilization.

6. This male cranium also had a possible trepanation (Sankhyan and Robbins Schug 2011), although this remains to be confirmed through imaging technologies.

7. Robbins Schug and colleagues (2012) and Lovell (2014a) also reported postcranial injuries in the cemetery R-37 assemblage, but it is often difficult to determine whether postcranial injuries are intentional. Thus, they are left out of any calculations of prevalence related to interpersonal violence.

8. A "mass of animal bones" was also found near her cranium, but no further details are provided in the excavation report (Vats 1940, 222).

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11

Hopewell Hierarchy or Heterarchy?

The Skeleton at the Feast

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The Hopewellian cultures of Eastern North America endured for some 500 years, encompassing the beginning of the Common Era. They extended from the Gulf Coast to Ontario and from West Virginia to Kansas. In the Midwest, the Hopewell are widely known for their spectacular earthworks, elaborate burial mounds, and regionally differentiated mortuary practices. Long-distance exchange in exotic materials and artifacts points to communication across ethnic boundaries. Many of these artifacts were deposited with the Hopewell dead. By far, the largest and most intensively studied group of Hopewell burials is from the Gibson and Klunk mound groups surrounding Kampsville, Illinois. The former is curated at the Center for American Archaeology and the latter at Indiana University.

As with many who became anthropologists in the heyday of the New Archaeology, the senior author has been fascinated by the proposition that mortuary practices express and reflect social structure. The complexity of mortuary practices and the beauty and elaboration of grave goods from the Hopewell cultures of the American Midwest have long captured the attention of archaeologists. In the era of the New Archaeology, Hopewell provided the arena for a lively debate about rank, status, and inequality in prehistory (and for a review of the sometimes heated controversies centered on the Gibson and Klunk mound groups, see Carr and Case 2004). As a physical anthropologist, the senior author has been interested in the relationship between distinctions in mortuary practices and the skeleton. Is status truly written on the body? Can skeletal markers of health and genetic relationship provide an objective measure of inequality?

A First Synthesis of Hopewell Status

Jane Buikstra (1976, 1979) first pioneered the search for skeletal markers of Hopewell social status. She showed that adult male stature at the Gibson mound group varied with status. Hopewellian men who were afforded elaborate mortuary treatment were taller than those whose burials were more modest. She discussed her findings as consistent with either an achieved or an ascribed model of status. Over the next decade, Buikstra invested her own and her students' work in the growing collection then at Northwestern University and now at the Center for American Archaeology in Kampsville, Illinois, and we did the same at Indiana University. Collectively, we have added to the picture of Hopewell social organization. Status groups were shown to differ in arthritis patterns at the elbow at Gibson (Tainter 1980), a pattern that suggests a higher workload involving rotational movement at the elbow among people who were not given elaborate burial. Trace element studies showed a complex pattern of differences between status groups that included lower levels of strontium, zinc, magnesium, and sodium in high-status Gibson individuals (Buikstra et al. 1989; Lambert et al. 1979).

The senior author's contribution, a chapter in *The Archaeology of Death* (Cook 1981), demonstrated that disturbances in the development of the enamel of first permanent molars were more frequent in low-status Hopewell burials from the Pete Klunk mound group than they were in high-status burials. The enamel of the first molar is formed between birth and three years of age, so this finding shows that high- and low-status Hopewell people had different health and nutrition as children and hence contrasting life experiences. These experiences were systematically related to status distinctions expressed at their eventual deaths. While Buikstra's findings on adult stature were consistent with both an achieved and an ascribed model for status, Cook (1981) pointed to ascribed status because it is difficult to imagine how two-year-olds might have achieved higher status than their peers.

Buikstra summarized the accomplishments of this joint effort: "Thus for at least the Gibson-Klunk Mounds, there is clear skeletal support for stable inter-generational transfer of resource control. The degree to which this pattern also characterizes other Middle Woodland communities remains a subject for further investigation" (Buikstra 1988, 18).

Hopewell Status in Context

Here, high status refers to both elaborate mortuary processing and access to exotic and elaborate grave goods. In such contexts, after primary burial in a semi-subterranean tomb or crypt, the body was often curated for a period until the flesh had decomposed, then deposited as a secondary burial on the ramps of these tombs or in bundle burials (see Brown 1979). Following Brown's concept, both persons buried in tombs and those placed bundle burials are considered to be high status in what follows. The final persons placed in the tombs or crypts remained there with their elaborate grave offerings in place, while bodies who were given a secondary burial have few or no grave goods. Tainter has quantified the volume of earth moved and other measures of energy expenditure in burying the elite (Tainter 1980). These mortuary practices required extensive manipulation of decomposing or partially mummified bodies over a substantial period of time (Cook 2005; Cook and Farnsworth 1981; Dragoo and Wray 1964). One imagines that ritual specialists carried out these activities.

In contrast, the majority of Hopewell burials at Gibson and Klunk were simple primary burials with few grave goods. The binary distinction drawn here is a gross simplification of a complex mortuary program, as Jim Brown (1979, 1981) has pointed out. It is driven in part by the necessities of statistical testing; despite the uniquely large collection of burials at Gibson and Klunk, it is still problematic to categorize status among the privileged few any more elaborately. The excavator of both mound groups, Gregory Perino, used to joke that there were too many chiefs and not enough Indians.

Hopewell societies across the Midwest display broad similarities, but local variations in community organization, mortuary practices, artifact styles, and ethnohistoric analogy suggest that many ethnically distinct communities shared aspects of material culture through long-distance trade and social interaction. The regional distinctiveness in mortuary practices (Brown 1979, 1981; Carr and Case 2004) is reflected in biological distinctiveness less than one might expect. In west-central Illinois, Hopewell populations show a riverine organization of biological diversity (Buikstra 1976), and one would expect from data on adaptive emphases and artifact styles that this pattern would apply in other regions as well. Despite their geographical and chronological separation, Ohio Hopewell and Illinois Hopewell are closely linked in biological distance studies, whether morphological data (Pennefather-O'Brien 2006; Reichs 1974) or mitochondrial

DNA (Bolnick and Smith 2007) are used. Hopewell crania appear to be more closely related to Archaic Amerindians than to recent groups in a larger-scale study (Nelson 1988). Despite all these statements, the Gibson and Klunk mound groups provide the sample sizes that permit statistical testing.

However, by the end of the 1970s, the status model of Illinois Hopewell was in eclipse. Jim Brown (1979) argued that Ohio Hopewell was more complex than its western kin. In a comprehensive reanalysis of the Gibson and Klunk data, David Braun argued for a radically egalitarian interpretation of mortuary programs (Braun 1981). He dismissed the evidence from human skeletons thusly:

> Some unusual patterns exist in the distribution of skeletal indicators of individual health histories, and in the treatment of women and children when interred in the same facility as an adult male. These patterns suggest that achieved social dominance varied among families as well as among individuals. (371)

This rethinking of the link between hierarchy and mortuary practices has generated a continuing and thorough critique of the ethnographic studies on which the Binford-Saxe paradigm was founded, and that paradigm is less popular than it once was, at least in North America.

More Evidence for Hopewell Status Differences

In the intervening two decades, several additional studies have confirmed that Hopewell status distinctions were literally written on and in the body. High- and low-status burials in this simplified sense differ in trace element content, isotopic signatures, some details of arthritis patterning, and pelvic morphology.

Buikstra's (1976) analysis of stature differences was confined to the Gibson series. A parallel study of the Klunk series shows a similar pattern: males who were buried in tombs and/or afforded secondary burial were over three centimeters taller than males who were not afforded elaborate burial treatment, while female stature did not differ with status (Young 1983). These results are compared with the Gibson results in Table 11.1.

The late Larry Angel (1982) developed a novel research program for assessing social inequality in his research on African American remains that focuses on flattening of the pelvis and the cranial base as markers of poor nutrition in childhood. His innovation was likely driven by the so-

Table 11.1. Stature in Middle Woodland adults from Klunk and Gibson

	Klunk[a]		Gibson[b]	
	Mean	N	Mean	N
Low-status females	158.0	35	158.8	31
High-status females	157.5	44	—	—
Low-status males	168.1	35	165.8	17
High-status males	171.4	42	174.1	9

[a]Klunk calculated stature using the femur, fibula, humerus, or radius in order of preference using the Trotter and Gleser stature estimation technique. Student's *t*-test for the male status difference is significant.

[b]Gibson reported stature using the Genóves estimation technique; females not separated by status (Buikstra 1976). Student's *t*-test for the male status difference is significant.

called African American paradox: tall stature in those who were enslaved or disadvantaged may reflect genetic differences and survivorship rather than living conditions. The British data on social class differences on which Angel relied reflect platypelly resulting from less severe manifestations of rickets.

We applied his model to the problem of Hopewell status distinctions. High-status women had higher pelvic indices (or rounder pelves) than low-status women in the combined Gibson and Klunk series (Brinker 1983) (Fig. 11.1). It is noteworthy that the 517 excavated burials yielded just 46 measurable pelves and that the seven low-status women for whom the pelvis could be measured were taller than their 18 high-status neighbors, unlike the larger sample for whom stature could be calculated. Just one Hopewell woman was platypellic, and there is little reason to think that rickets was common in the ancient Midwest.

In contrast, there were 74 adult crania from Klunk alone with measurable cranial base height. The Middle Woodland status groups showed no significant difference in cranial base height (Salter-Pedersen 2006). Cranial base height also failed to show significant differences in comparisons of sexes or groups based on the presence or absence of cranial deformation and cribra orbitalia using an ANOVA model. Females with and without porotic hyperostosis differed in cranial base height, suggesting that Angel's method does capture environmental effects on the growing skull, even if it is not related to mortuary distinctions among the Hopewell. Despite the excellent preservation at Gibson and Klunk mounds, the proportion of individuals who could be evaluated using Angel's method was disappointing,

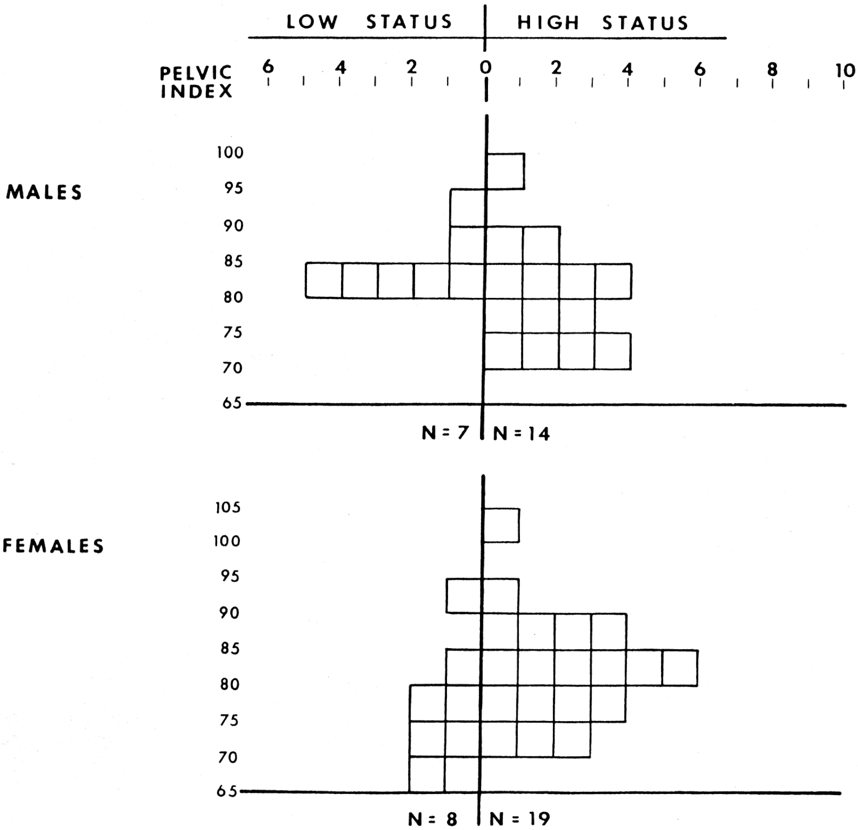

Figure 11.1. Pelvic index values for the Gibson and Klunk status groups, sexes separated.

and we did not find the correlations he reported between either cranial base height and pelvic index or stature and pelvic index.

Trauma analysis provides a view of behaviors tied to the social context of ancient persons. One unfortunate adolescent girl from the Hopewell component at Klunk had experienced both healed and time-of-death cranial trauma and she may have been developmentally disabled. She was buried in the grave fill of an adult male whose grave was unusual in that he was buried face down but lacked all features indicating high status (Cook et al. 2014). A more systematic study of 124 well-preserved Hopewell adults from Klunk revealed that 31, or 19 percent, had suffered fractures. Six females displayed parry fractures, whereas Colles' fractures, usually produced by falls, were evenly distributed by sex, a pattern that suggests domestic abuse (Moser 1994). This interpretation of forearm fractures has been questioned (Lovell 1997), but it has been widely used among paleopathologists. Cranial

Table 11.2. Healed fractures in Middle Woodland adults from Klunk

	Male			Female		
	High	Low	Unknown	High	Low	Unknown
Nasal	—	1	—	4	2	—
Frontal	—	—	—	1	3	—
Parietal	—	—	—	—	1	—
Mandible	—	—	—	—	1	—
Clavicle	1	—	—	2	—	1
Humerus	—	1	—	—	1	—
Ulna	1	1	—	3	3	—
Radius	1	1	—	3	—	—
Metacarpal	2	—	—	—	—	1
Rib	1	2	1	1	—	—
Acetabulum	—	1	—	—	—	—
Tibia	—	1	—	—	1	—
Fibula	—	1	—	1	2	—
Metatarsal	1	1	—	—	—	—

Note: Well-preserved, essentially complete skeletons; data from Moser (1994).

trauma supports our interpretation. Twice as many "high-status" women had fractures compared with women who received simple burials, a finding that may point to ritual combat or interpersonal violence as a component of social distinction. While parry fractures were evenly distributed between status categories, nasal fractures were more common in high-status women (four of six; see Morse 1969, 86, Figure G) and frontal fractures and other head trauma were more common in low-status women (1 of 4). In comparison, just one nasal fracture and no vault fractures were seen in men (Table 11.2). At Klunk the fabled "Pax Hopewelliana" (Seeman 2007, 169) may not have extended broadly to women, particularly those who were afforded elaborate mortuary treatment.

The dietary differences that contributed to trace element composition contrasts between high- and low-status individuals at Gibson are mirrored in isotopic studies of the Klunk series. Higher apatite and carbonate-collagen $\delta^{13}C$ spacing in low-status individuals from Klunk suggests that the diet of persons who were not given elaborate burial may have contained less overall protein (Schober 1998). This result would be consistent with male stature differences.

Diet and activity were combined in a recent study (Husmann 2011) that showed substantial differences in maintenance of vertebral trabecular bone with regard to mortuary practices in individuals from the Klunk Middle

Woodland series. Central tomb burials had the lowest trabecular bone densities, while burials near central features had the highest bone densities; peripheral burials were characterized by intermediate bone density values. This contrast is obscured if the first two categories are combined, as Brown (1979) has argued. For the whole series, radial diameter was related to bone density. Together these results suggest heterogeneity without presenting an unambiguous signal of social status differences. The Middle Woodland elite might be characterized as being less active, as having a greater dietary contribution of meat, or both. Activity is also reflected in arthritis patterns. Ólafardóttir's (2016) careful analysis of Klunk Middle Woodland arthritis fails to confirm Tainter's finding of differing arthritis patterns in central tomb and other burials, although she suggests that other mortuary components may reflect different lifestyles and activities.

Oral health presents a similarly complicated picture. Klunk Middle Woodland females who were given elaborate mortuary treatment show more antemortem tooth loss and dental caries than do women whose burials were simple. However, no contrast is found among males (Spitznagle 2011). Oral health differences arise from many causes, primarily from the carbohydrate content and stickiness of foods, but hygiene, life history, and occupational factors are important as well.

Mitochondrial DNA studies of Klunk do not support the notion that status distinctions at Klunk might have reflected matrilineal groups (Bolnick and Smith 2007). This result is consistent with Jane Buikstra's analysis of cranial nonmetric variation: "There is no stable genetic relationship defining access to specific structural features within the mounds" (Buikstra 1976, 57).

The physical distinctions in persons who were given elaborate or simple burials at Klunk and Gibson are quite robust to recursive analysis. They indicate different paths for men and women toward differential treatment in death. Why have these findings been largely ignored by Midwestern archaeologists, and why have they proved difficult to publish further?

Memento Mori

When Chapman et al.'s *The Archaeology of Death* (1981) was published, most applications of data from human remains to an understanding of mortuary practices considered just the age and sex of the deceased. Life history variables such as developmental stability, nutrition, deformity, and disability have the potential to enrich our understanding of social distinctions.

This review questions why this promise remains largely unrealized. For the senior author, revisiting a publication after two decades raises mixed emotions—part nostalgia and part regret. Her contribution to *The Archaeology of Death* is her least cited paper. It sank like a stone. What were some of the factors that may explain this disappointing outcome?

A primary difficulty lies in the arcane nature of the dental data. Perhaps it was a mistake to publish a study of enamel quality in a volume of collected papers on mortuary practices. The result has been that neither archaeologists nor even highly specialized dental anthropologists cite the chapter. Not even the energetic and thorough Simon Hillson (1996) picked it up.

Another difficulty, we believe, arises from the uniqueness of the Gibson and Klunk collections. Gregory Perino, who was responsible for excavating these two mound groups, completely excavated 21 of 26 mounds that surrounded the modern village of Kampsville, Illinois, and the Hopewell and Archaic habitation site referred to as Buried Gardens of Kampsville. The resultant collection of 528 individuals is far larger than any other Hopewell series and is very well preserved. This embarrassment of riches has permitted skeletal analyses at Gibson and Klunk that cannot be replicated elsewhere at other Hopewell sites. Testing hypotheses about status distinctions requires well-excavated and well-contextualized samples that are large enough to permit statistical testing while controlling for age, sex, and environmental influences. This is not the place to review the whole of the Middle Woodland literature for Eastern North America, but most analyses of status elsewhere have been limited to studies of grave goods and mortuary processing with attention paid at most to age and sex of the deceased (for example, Carr and Case 2004; Jeffries 1976; Ruhl and Seeman 1998; Mainfort 2013).

Brown's (1981) nuanced rejection of rank as a model for Gibson and Klunk mortuary practices is based on an age-sex data set that is large enough to evaluate subtle differences in access to aspects of mortuary treatment, although his argument is frequently glossed as "all ages and both sexes." Stature estimates are available for surprisingly few of the many Middle Woodland dead excavated in Ohio (Perzigian et al. 1984). For example, excavators' field estimates of stature for the Hopewell type site in Ohio are suspect, and the surviving curated skeletal material does not permit reanalysis (Johnston 2002). Physical anthropological study of the Ohio Hopewell remains is also complicated by cremation, a practice that may have expressed status distinctions, an interpretation that was made in the

earliest systematic studies of these sites (Silverberg 1968) but that severely limits further analysis. Much of the senior author's narrow regional focus is justified by these sample limitations, but colleagues from other regions may question the general relevance of studies from a single community in west-central Illinois.

A third difficulty lies in the details of the "two climax model" that has dominated Midwestern prehistory for most of the last century (Hall 1980). Social complexity is seen as having peaked in Hopewell between 150 BC and AD 150, declining during the Late Woodland, and then peaking again in the Mississippian after AD 1000. Archaeologists have depended on historical accounts of slavery, sacrifice, and sumptuary rules among the Natchez and other historic southeastern groups to inform their interpretations of the archaeological record for the latter "climax" in cultural complexity. As a result, they have seen Mississippian chiefdoms as highly socially stratified. It is no accident that the first and most prolific attempt to read status written on the body in eastern North America is James Hatch's series of studies of Mississippian Dallas Phase burials from Tennessee (Hatch 1975; Hatch and Willey 1974; Hatch and Geidel 1983, 1985; Hatch et al. 1983).

Archaeologists interested in Mississippian status distinctions read these societies as stratified (e.g., Milner 1992; Welch and Scarry 1995), even when many studies of distinctions in mortuary practices or skeletal markers fail to support this reading (Buikstra et al. 1989; Goldstein 2006; Hodge 2005; Powell 1988; Schurr and Schoeninger 1995). Social distinctions are clearly visible in evidence such as mortuary practices and isotopic signatures at the apex of Mississippian social hierarchy, as Ambrose and colleagues have recently demonstrated for Mound 72 at Cahokia (Ambrose et al. 2003). Nevertheless, the egalitarian model for remains from prehistoric American Indian societies has induced a sort of blindness among archaeologists regarding evidence of hierarchy (Kehoe 1998). A recent collection of essays attempts to read Mississippian mortuary practices without recourse to hierarchic models (Sullivan and Mainfort 2010), and a heterarchy model has been recently applied to even Cahokia, the apex of Mississippian social complexity (Byers 2006).

In contrast, there is no clear ethnographic model for the Hopewell cultural "climax." The fallback model that was built into American perceptions of Native American societies long before the emergence of archaeology as a discipline originates with views of the Iroquois, who were stereotypically viewed as democratic and egalitarian (Sheehan 1974). Indeed, the National Parks Service has embedded this model into the central icon of its depic-

tions of ceremonial life at the Hopewell Culture National Historical Park at Mound City, Ohio. A mural by artist Louis Glanzman presents what is known of Hopewell regalia on men sporting a hairstyle that is commonly called a Mohawk—a midline roach with shaved sides—in what appears to be an Iroquois longhouse. This image is reproduced on the cover of *Gathering Hopewell* (Carr and Case 2004). The evidence we have for Hopewell hairstyles suggests considerably more complexity, with no hint of northeastern connections (Brose et al. 1985; Dragoo and Wray 1964), and elite Hopewell women are missing from Glanzman's reconstruction altogether.

As Alice Kehoe (1998) has pointed out, this bias toward interpretations of egalitarianism has prevented archaeologists from seeing the complexity of Cahokia, and we think the same argument can be made for Hopewell. Because the bias is congruent with the strongly nativistic and egalitarian bent of many eastern North American archaeologists, we think this stereotype has prevented our archaeological colleagues from accepting skeletal research that supports ascribed or lifelong status distinctions. So-called big man performance, leadership, or entrepreneurial models for Hopewell status (for example Carr and Case 2004; Mainfort 1985; 2013) dominate the recent literature, and they focus on achieved status. They are inconsistent with lifelong status distinctions expressed in skeletal signatures of diet and disease. If Indians were egalitarian democrats, why should one look for status distinctions in their bodies? If the Hopewell elite were shamans (Brown 2006), should we expect them to have experienced privileged childhoods?

An interesting reflection of the workings of this bias can be seen in Steckel and Rose's recent meta-analysis of skeletal data on stature and health in their project *The Backbone of History* (2002). While a coding for mortuary status distinctions is a uniform feature of the project, social stratification is discussed only for Euro-American and Afro-American data, not for the American Indian remains that are the main component of their data.

A final difficulty lies in the paradigm shift that has overtaken archaeology since the 1980s. In a recent review, Lynne Goldstein (2006) makes the point that the archaeology of mortuary practices has moved away from a simplistic equation of status with distinctions in grave goods and toward broader readings of religious and symbolic meanings. She argues that physical anthropology and archaeology have followed divergent paths. Similarly, in a content analysis of archaeological literature, Rosemary Joyce (2005, 141) has pointed out the remarkable productivity of physical anthropologists in what she calls the archaeology of the body. She comments that "simultaneously, the frequency of articles concerned with the body,

considered from the perspective of bioarchaeology, has sharply increased, and these contributions are in no way postprocessual." And then she proceeds to discuss the postprocessual literature. We make no apologies; most physical anthropologists are unreflective positivists. However, we do see it as unfortunate that postprocessual archaeology has turned away so decisively from the data and interpretations that physical anthropologists can contribute. Joyce's table also reveals the influence of the Native American Graves Protection and Repatriation Act, which passed in 1990. In our view, it was the stimulus for much of the increased productivity that Joyce documents. Simultaneously, we fear that it has led many of our archaeological colleagues to distance themselves from skeletons and the status distinctions that are written on and in them. The field is in danger of constructing an archaeology of the body that lacks any skeletons.

The Skeleton at the Feast

> Heterarchy may be defined as the relation of elements to one another when they are unranked or when they possess the potential for being ranked in a number of different ways. . . . While hierarchy undoubtedly characterizes power relations in some societies, it is equally true that coalitions, federations, and other examples of shared or counterpoised power abound. (Crumley 1995, 3)

The analytical contrast of hierarchy with heterarchy has been applied to many ancient societies since it was pioneered by Carole Crumley (1995), but it is curiously infrequent in the literature on Hopewell. Chris Carr (Carr and Case 2004) has perhaps approximated the concept in defining a middle ground between the divergent views of the Gibson-Klunk mortuary program, but he stresses horizontal organization, identity, and leadership and he devotes little attention to physical distinctions among the dead.

Variations on this relatively egalitarian view of Hopewell have become common among archaeologists. To quote a recent example:

> From this perspective Hopewell populations are seen as composed of small scale, tribal societies whose inter-tribal or inter-community relationships exhibited a "sequential hierarchy" (aka heterarchy) rather than a genuine, vertical hierarchy. . . . A Hopewellian heterarchy might have involved *ad hoc* social relationships between individual communities that arose in response to problems facing the entire local population. (Dancy 2005, 127)

On the other hand, Carole Crumley has made a perhaps offhand suggestion that Hopewell was hierarchical and that its collapse reflects heterarchy:

> Does resistance to hierarchies leave material evidence? Perhaps widespread evidence for the collapse of political organizations and the continuity of their populations point to resistors' successes. . . . Do social movements leave material evidence? Perhaps that can explain the disjuncture between Middle Woodland societies, widespread in eastern North America, and the more limited distribution of Hopewell symbolism. (Crumley 2005, 49)

Despite her suggestion, Crumley's fluid concept of heterarchy fits the present-day archaeological perspective on Hopewell remarkably well, but the skeletal evidence contradicts this interpretation. Perhaps for this reason the skeletal evidence is all but ignored in most recent syntheses. Dancy (2005) mentions Buikstra's demonstration of male stature differences at Gibson but fails to integrate it into his interpretation. Carr's more detailed catalog of Scioto Hopewell mortuary sites limits its treatment of human remains to age and sex (Case and Carr 2008). Abrams's (2006) extensive recent review of Hopewell archaeology is silent about inferences about social distinctions from skeletal remains. Even more curious is the absence of inference from skeletal data in Charles and Buikstra's edited volume *Recreating Hopewell* (2006).

In her careful analysis of Ohio Hopewell mortuary use of objects made from human bone, Cheryl Johnston (2002, 25) summarizes the perplexing state of affairs among archaeologists:

> Ironically, it seems that many of the same lines of evidence that have been used to support the old scenario in the past can be used to support the opposite view of Hopewell: that they were socially complex yet were not organized by rank, were sedentary yet were not agriculturalists, and that their interactions were based on maintaining social ties and prestige through gift giving instead of through economic means associated with the accumulation of wealth.

Perhaps the paradigm that has created this puzzle is about to change. In a thorough study of mound building in the southern Mississippi Valley, Sherwood and Kidder (2011) argue that mound building has been viewed as simple activity when it fact it is a form of architecture requiring specialists with detailed knowledge of techniques and materials. Their focus is not on burial mounds, but the same points they make regarding skill, organi-

zation, and arcane knowledge are equally relevant to Middle Woodland burial mounds further north, where similarly complex architecture in soil has been interpreted symbolically (van Nest et al. 2001) rather than for the specialization and social control that this complexity implies.

In Petronius's *Satyricon*, a silver skeleton serves as both a memento mori and as a symbol of social climbing, outrageous self-display, and conspicuous consumption. This "skeleton at the feast" more recently has come to mean an unwelcome guest. The osteology of Hopewell human remains has come to be something of an unwelcome guest in the archaeological literature on Hopewell social complexity. Any theory of Hopewell heterarchy must confront the skeletal evidence of differences in diet, health, and life history in those who were afforded elaborate mortuary treatment and those who were not. These differences are on the order of magnitude of those seen in highly stratified contemporary societies. It is difficult to reconcile this evidence of inequality with any model of Hopewell society that does not include substantial hierarchy, however multiple, horizontal, complex, and networked the expressions of Hopewell power and identity may have been. The skeleton remains a guest at the table, however unwelcome.

Conclusion

An enormous body of evidence from contemporary studies of human biology supports the proposition that social status is truly written on the body (Goodman and Leatherman 1998), even in societies who have an egalitarian ideology. We continue to think that evidence from bones and teeth is both compelling and useful in understanding the meaning of mortuary practices. We know more about Middle Woodland society as a result of detailed analysis of their physical remains, not just their artifacts. Recursive testing using complementary data sets provides a rich understanding of the health, activity patterns, and inequality among the Hopewell. The magnitude of these differences approximates that found in comparisons of classes or castes in complex societies. It is difficult to see how these data can be accounted for without resort to hierarchical models of access to resources, however tempered by heterarchies of alliances, symbolisms, or values. Findings from human remains provide an otherwise missing level of objectivity in evaluating models for ancient social interaction. Has physical anthropology also become an unwelcome guest at the archaeological table in the era of repatriation?

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12

Status-Based Differences in Health in the Late Prehistoric East Tennessee

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The investigation of skeletal manifestations of social status has become an arguably standard inquiry in bioarchaeology. Studies focus on a range of biological markers of health (Blakely and Beck 1981; Pechenkina and Delgado 2006; Powell 1991; Robb et al. 2001), diet (Betsinger and Smith 2013; Blakely and Beck 1981; Cucina and Tiesler 2003; Kjellström et al. 2009; Le Huray and Schutkowski 2005; Reitsema and Vercellotti 2012; Schutkowski et al. 1999; Smith et al. 2011; Ubelaker et al. 1995; White et al. 1993), and occupation/lifestyle (Havelková et al. 2013; Jankauskas 2003; Woo and Sciulli 2013). The results of these investigations are varied. In some instances there are status-based differences (e.g., Betsinger and Smith 2013; Cucina and Tiesler 2003; Jankauskas 2003; Kjellström et al. 2009; Le Huray and Schutkowski 2005; Pechenkina and Delgado 2006; Reitsema and Vercellotti 2012; Schutkowski et al. 1999; Smith et al. 2011; Ubelaker et al. 1995; White et al. 1993), while in others, status does not correlate with a biological parameter (e.g., Blakely and Beck 1981; Powell 1991; Robb et al. 2001; Woo and Sciulli 2013). Moreover, when biological differences related to status are found, they are not always consistent throughout the population. For example, status-based differences observed in males may be absent or greatly reduced in females (e.g., Cucina and Tiesler 2003; Havelková et al. 2013; Reitsema and Vercellotti 2012). Collectively, these results reflect both the tremendous variability of social status and its role in different cultural groups and the wide range of potential impacts of status on various aspects of human biology, including health or biological stress. Despite the inconsistent outcomes of such studies, research in this area continues in order to address the big question of whether social status impacts skeletal biology, a fundamental question of the biocultural approach. This chapter examines multiple lines

of skeletal evidence to address the possible links between social status and skeletal pathology in the Late Mississippian period in Tennessee.

Archaeology and Funerary Patterns at Toqua and Citico

The Mississippian period (AD 900–1600) marked a major transition from the previous Woodland period (900 BC–AD 900) in the American Southeast (Chapman 1994). While the Woodland period was marked by incipient agriculture and the construction of burial mounds, the Mississippian tradition yielded large, aggregated, and sedentary populations engaged in intensive maize agriculture. As population size grew and densely populated settlements were developed, territoriality increased, as did warfare. In addition, organized chiefdoms developed and elaborate religious ceremonialism evolved. Earthen platform mounds were built with various buildings constructed at the top, including elite residences and ceremonial and sociopolitical buildings (i.e., council houses) (Chapman 1994).

Social organization during the Mississippian period involved chiefs who had sociopolitical influence not only over the populations who lived at the large settlements where they resided but also over large populations in the surrounding territory (Chapman 1994). The location of the chief's residence was the economic, religious, and social focus for the region. This is highlighted by the large earthen mounds erected at these sites. Within a territory, in addition to the large mound center, there were "lesser mound centers, hamlets, and farmsteads" (Chapman 1994, 74; and see Ross-Stallings, this volume). Populations were likely structured according to matrilineal kinship, with clans that constituted several hereditary ranked lineages (Chapman 1994; Hudson 1976). Matrilineages owned agricultural lands and houses and held rights to certain ceremonies (Hudson 1976).

In the Little Tennessee River Valley of eastern Tennessee, there were likely three major mound centers (Chapman 1994), including the multimound site of Toqua (Schroedl 1998). Thirty other village sites have been identified in the surrounding region (Polhemus 1987). One of the major mound centers, Toqua (40MR6), was used in this study in addition to a single-mound site, Citico (40MR7). It has been suggested that in this region during the Mississippian period, a site with multiple mounds was paired with a single-mound center, making them the largest settlement in a single Dallas polity (Schroedl 1998, 74).

Toqua was a large, palisaded town that covered at least 18 acres in the Little Tennessee River Valley (Polhemus 1987; Sullivan 2006). As a multi-

mound center it may have been home to the main chief or chiefs of the region. However, there is no archaeological consensus regarding the presence of paramount chiefs in this region of Tennessee (L. P. Sullivan, pers. comm., 2006). The primary platform mound, the lesser mound and a possible charnel house formed a triangle, and there was a large plaza in the middle of the village that may have been the location of various public buildings (Schroedl 1998, 74–77). During the 1975–1977 excavations, archaeologists discovered that both mounds had evidence of multiple phases of construction and that the larger, primary mound was built over at least 15 discrete phases (Chapman 1994; Polhemus 1987; Schroedl 1998). In addition, three sets of palisades were excavated, each subsequent palisade enclosing a smaller village area and the mounds. However, the final palisade did not encompass the smaller of the two mounds. This reduction in size of the site may reflect the dispersal of the population due to soil fatigue and loss of crops (Schroedl 1998). More than 477 burials containing nearly 500 individuals were discovered during excavations from both the mound and village areas of Toqua (Chapman 1994; Polhemus 1987). Burials were recovered from both mounds and from within and outside domestic structures in the village areas (Schroedl 1998). Archaeologists argue that these village burials are located near the residence of the deceased (Lewis and Kneberg 1946, 1958; Schroedl 1998).

Citico was a considerably smaller palisaded site with a single mound (Chapman 1979) that was contemporaneous with Toqua. Excavations revealed several construction phases of the mound (Chapman 1979; Salo 1969). Unlike at Toqua, no evidence was recovered of buildings erected on the summit of the mound. However, this may be due to destruction of evidence from erosion or modern farming (Salo 1969). Excavations uncovered 133 burials that contained the remains of approximately 185 individuals (Chapman 1979). The burials were recovered from the mound (mostly near the summit) and in the village areas, including in the South Section, where a high concentration of burials was recovered near two buildings, presumably houses (Salo 1969).

The Dallas phase of the late Mississippian period (AD 1300–1600) is the terminal prehistoric phase of the Mississippian era. Prior to this phase, burials were located outside the palisaded village; during the Dallas phase, the deceased were interred in the mound and in the village areas as described above (Lewis and Kneberg 1946, 1958; Schroedl 1998). The Dallas phase has been characterized by two-tiered (i.e., elites and non-elites) chiefdom-level societies (Hudson 1976). However, the chiefdom model has

come under scrutiny; some argue that its oversimplification may obscure diversity within and between regional polities (see review in Sullivan and Mainfort 2010). While the exact nature of the "chiefdom" at the Dallas phase sites of Toqua and Citico is unclear, variation in burial location is not. The majority of burials were located in the village areas beneath or in conjunction with various buildings, while a smaller number of burials are found in the earthen mounds (Polhemus 1987; Salo 1969).

The characterization of these two burial locations as representative of two status groups (elite and non-elite) has been long established for this region during the Mississippian period (Chapman 1994; Hatch 1976; Lewis and Kneberg 1946; Polhemus 1987; Sabol 1977; Schroedl 1998; Scott 1983; Sullivan 2001). For example, Scott (1983), who examined mortuary patterning at Toqua using an energy expenditure model, argued that burials requiring higher energy expenditure would likely reflect individuals with higher status. He found that the areas encompassing the mounds had the highest energy expenditure and, thus, that higher-status individuals were likely interred there. Conversely, village-area burials required lower energy expenditure, reflecting the lower status of the deceased (Scott 1983). The higher-status social stratum is identified by burial in an earthen mound, a greater number of grave goods overall, and more objects of nonlocal or exotic origin. In contrast, lower-status individuals were interred in village areas and were accompanied by fewer burial goods overall and fewer objects of nonlocal origin.

The idea of burial location and accompaniments and their association with social roles are deeply entrenched elements of mortuary archaeology. The development of archaeological mortuary theory is rooted in the study of Mississippian mortuary sites (Sullivan and Mainfort 2010, 1), and many well-known studies used data collected from such sites (e.g., Brown 1981; Goldstein 1981; Peebles and Kus 1977). Understanding the social dimensions of mortuary treatments has altered how archaeologists interpret Mississippian cultures (Sullivan and Mainfort 2010, 1). While Saxe (1980) argued a for representationist view of mortuary practices, that is, the idea that how an individual was buried was directly reflective of that person's role in life, more nuanced understandings of funeral rites argue that other elements influence these practices, including economics, politics, and the living (Rakita and Buikstra 2005). While it is clear that individuals are treated differently in death (Sullivan and Mainfort 2010), the full suite of factors that affect the mortuary rites of a particular culture and the variation in

these rites are not always known. Regardless, examining mortuary patterns is one way to gain insight into the sociopolitical constructs of a society.

Although it has been argued that burial location is indicative of social status (Goldstein 1981; Saxe 1970), at the eastern Tennessee sites described in this chapter, that linkage may be more relevant for males than for females because of the nature of gendered burial patterns in the Mississippian world (Sullivan 2001). Elite adult males were preferentially interred in the mounds, while elite adult females were likely interred near their homes (Scott and Polhemus 1987; Sullivan 2001, 2006). Historically, this discrepancy has been explained as reflecting the generally higher status of males over females in late prehistoric societies. However, this assumption may be oversimplifying far more complex and negotiated dimensions of political and social organization (Sullivan 2001, 2006). Throughout the Southeast, populations varied in the amount of power and authority females possessed, including societies in which females headed their clans or had roles as chiefs (Sullivan and Mainfort 2010). In some groups, there may have been strong heterarchies in which males and females had power and control in different areas of social life and decision making (Sullivan 2001, 2006). In other words, women controlled one sphere of life, especially relating to their kin groups, while males had greater influence in other social domains, such as the community as a whole. As a result, there is a clear sex bias in the mortuary patterning at the sites of Toqua and Citico, an important consideration when evaluating health disparities based on mortuary location in this region.

The substantial economic and demographic changes that characterize the Mississippian period likely resulted in shifts in patterns of morbidity and biological stress, especially due to increased maize consumption, sedentism, and population size, factors that are associated with a variety of health consequences (Cohen and Armelagos 1984; Larsen 1995, 2002). In addition, social stratification likely resulted in differential access to resources, such as meat (Bogan 1980; VanDerwarker 1999), leading to unequal levels of stress for the elite and non-elite strata of a population. In addition, elites may have had more methods of cultural buffering and better access to therapeutic care, thus reducing their exposure to and experience with sources of stress such as infectious disease or parasites. Indeed, earlier studies in the region have demonstrated such patterns (Hatch 1976; Hatch and Willey 1974; Hatch et al. 1983). For example, Hatch (1976), who examined stature differences based on burial location for five Dallas phase sites

in eastern Tennessee, found that males buried in the mound were significantly taller than males buried in the village area. This difference, however, was not observed for females. It can be inferred that since stature is influenced by nutrition, disease, and stress, the higher stature of males buried in mounds reflected their better overall health or nutrition. Collectively, these analyses suggest that elites had lower prevalences of skeletal pathological conditions and indicators of biological stress than did non-elites.

This study examines whether this previously observed regional pattern also existed at Toqua and Citico. Based on these earlier findings (Hatch 1976; Hatch and Willey 1974; Hatch et al. 1983), this study tests the hypothesis that archaeologically defined non-elites had more markers of stress (porotic hyperostosis, cribra orbitalia, linear enamel hypoplasias, and periostosis) than inferred elites due to differential access to resources, including dietary differences. As has been suggested in previous research (Betsinger and Smith 2007, 2013; Bogan 1980; VanDerwarker 1999), elites likely had more access to meat, consumed less maize, and had a better diet overall. Therefore, it is anticipated that non-elites had higher rates of porotic hyperostosis due to a lower quality of overall nutrition. Regardless of whether porotic hyperostosis is the result of acquired iron deficiency or nutritional megaloblastic anemia, this stress indicator reflects nutritional deficiency, especially as it relates to meat consumption, and/or chronic parasitic infection (Stuart-Macadam 1992; Sullivan 2005; Walker 1986; Walker et al. 2009). Furthermore, it is expected that non-elites will have a greater prevalence of cribra orbitalia, due to higher levels of specific nutritional deficiencies that may include scurvy, rickets, or anemia (Ortner 2003; Walker et al. 2009). While linear enamel hypoplasias in adult teeth are indicators of stress (including malnutrition and disease) during the time of their formation during childhood, the distribution of enamel defects are also anticipated to show status differences, since it is argued that in Mississippian society, status could be ascribed at birth in addition to being achieved throughout one's life (Chapman 1994; Hatch 1976; Parham 1982; Scott 1983; Scott and Polhemus 1987; VanDerwarker 1999). Levels of periostosis reflect exposure to pathogens, including systemic nonspecific infection and parasitism as related to settlement patterns and community sanitation (e.g., contaminated drinking water). Periostosis should be relatively equal between elites and non-elites, as they inhabited the same general area, although elites may have had greater buffering from exposure to these sources of stress, such as differential access to therapeutic care. In addition, nutrition can play a role in susceptibility to infection and immunocompetence (Lallo et al. 1978;

Larsen 2015). Because of the synergistic effect of a poor diet and infection (Powell 1988), it is anticipated that non-elites will show a greater prevalence of periostosis due to their lower quality of nutrition.

Materials and Methods

Adult skeletal remains were examined from the two previously described sites located in eastern Tennessee on the west bank of the Little Tennessee River (Fig. 12.1): Citico (40MR7; n = 121) and Toqua (40MR6; n = 194). These Dallas phase (AD 1200–1600) sites were excavated between 1967 and 1979 (Chapman 1994; Polhemus 1987) and were chosen for this study because they were part of a single sociopolitical polity and were inhabited contemporaneously (Schroedl 1998).

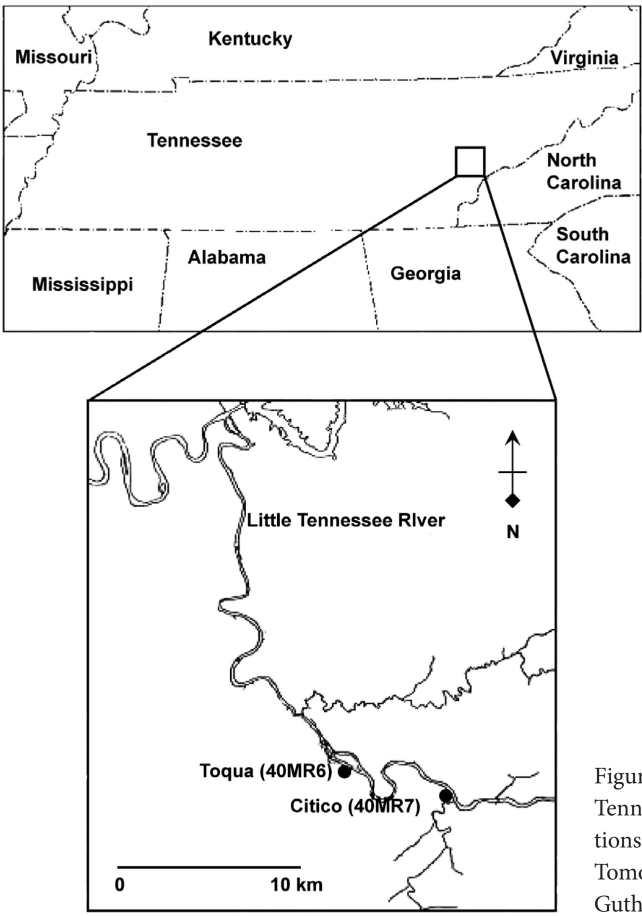

Figure 12.1. Map of eastern Tennessee, showing locations of Toqua, Citico, and Tomotley. Adapted from Guthe and Bistline 1978.

A total of 599 individuals were studied from both sites, of which 315 adults (>18 years) were included in this study. Estimation of age and determination of sex were previously conducted by a team of bioarchaeologists who followed methods outlined in Buikstra and Ubelaker (1994; M. O. Smith, pers. comm., 2015). Sex determination of adults was based on morphology of the pelvis and cranium (Buikstra and Ubelaker 1994). Adult age estimation followed the Suchey-Brooks pubic symphyseal method (Brooks and Suchey 1990 as described in Buikstra and Ubelaker 1994), and cranial suture closure (Buikstra and Ubelaker 1994) was used only to aid in distinguishing between middle adults (30–50 years) and older adults (50+ years). Subadult age estimates were developed using dental development and eruption and epiphyseal closure (Moorees et al. 1963a, 1963b; Buikstra and Ubelaker 1994). At least two researchers independently determined age and sex for a skeleton, and discrepancies were resolved by a third person (M. O. Smith, pers. comm., 2015). These age and sex data are contained in a permanent database managed by the F. H. McClung Museum in Knoxville, Tennessee (Smith 1982). The condition of the remains was generally good to excellent. Remains were not always complete, however, and both sites have a large number of adult individuals of indeterminate sex. Individuals lacking their anterior dentition, 50 percent of one orbit, 50 percent of a parietal bone, and at least two long bones were excluded.

The Citico sample yielded 36 adult males (31 non-elite, 5 elite), 47 adult females (44 non-elite, 3 elite), and 38 adults of unknown sex (18 non-elite, 20 elite). The Toqua sample contained 62 adult males (47 non-elites, 15 elites), 56 adult females (47 non-elites, 9 elites), and 76 adults of unknown sex (17 non-elites, 59 elites). A Kolmogorov-Smirnov test of the age distributions of the two samples indicates that there is no statistically significant difference in age distributions between the Citico and Toqua samples ($p \leq 0.05$).

Only adults were included in this study, as status was likely a combination of acquired and achieved aspects of people's social experiences and personae (Chapman 1994; Scott and Polhemus 1987). It is possible that some subadults inherited a sufficient status to warrant mound burial, as there are some subadults in the mounds, but the majority of this age group were buried in village areas, likely reflecting their age and lack of opportunity to achieve the highest status levels.

All skeletal remains were examined for evidence of the biological stress indicators described earlier and were recorded as present or absent. Porotic hyperostosis and cribra orbitalia were considered to be present based

on the presence of fine foramina, larger foramina, coalescing foramina, or increased thickness of the bone (after Buikstra and Ubelaker 1994). Linear enamel hypoplasias were scored for the anterior dentition (i.e., incisors and canines), since hypoplastic defects have a predilection to manifest in these teeth (Goodman and Rose 1990). At least 50 percent of the crown was required to be intact for an assessment to be made. In addition, for a defect to be considered present, the defect had to be palpable, capable of identification by touch. Periostosis was scored for the major skeletal elements (i.e., humerus, radius, ulna, femur, tibia, fibula, clavicle). Each individual was classified as present if at least one skeletal element showed evidence of abnormal hypertrophic bone formation and was classified as absent if there was no evidence. Periostosis was considered to be present based on evidence of new bone formation, hypervascularity, mild to significant amounts of new bone deposition, and abnormally expanded diaphyses.

Straightforward, nonparametric statistical tests were used to determine whether significant differences existed in lesion patterning between the elite and non-elite samples, including chi-square tests when sample sizes were above five and Fisher's exact test when sample sizes were less than five. The confidence level was set at 95 percent.

In order to avoid the confounding effects of gendered mortuary patterns in which most of the mound burials are males, adult males and adult females were also analyzed separately for each of the stress markers. In addition, since the two sites are contemporaneous and geographically similar, analyses were performed on a combined sample of Citico and Toqua. This helped minimize any error introduced by the small size of the elite component at each site.

Results

Mound burials and village burials were compared in order to elucidate any patterns of health related to mortuary location. The results of the comparisons of the elite and non-elite components of Citico and Toqua reveal several statistically significant patterns (see Tables 12.1–12.3; Betsinger 2002). In the adult (combined sex) sample for both Toqua and Citico, porotic hyperostosis was significantly higher in the non-elites than in the elites ($p = 0.0002$, $p = 0.0001$, respectively). In addition, at Citico, non-elite adult males had a significantly greater prevalence of porotic hyperostosis than elite males ($p = 0.05$). Adult males at Toqua and adult females at both Citico and Toqua did not reveal statistically significant variation in the prevalence

Table 12.1. Stress marker frequencies for combined sex, adult males, and adult females at Citico

Stress Marker	Mound (n^1/N^2, %)	Village (n^1/N^2, %)	*p*-value
Combined sex			
Porotic hyperostosis	0/21 (0)	36/90 (40.0)	0.0001*
Enamel hypoplasias	7/26 (26.9)	49/83 (59.0)	0.0043*
Cribra orbitalia	0/2 (0)	2/56 (3.6)	1.0000
Periostosis	0/21 (0)	18/91 (19.8)	0.0222*
Adult males			
Porotic hyperostosis	0/5 (0)	18/31 (58.1)	0.0455*
Enamel hypoplasias	3/5 (60)	19/30 (63.3)	1.0000
Cribra orbitalia	0/1 (0)	2/22 (9.1)	1.0000
Periostosis	0/5 (0)	9/31 (29.0)	0.3017
Adult females			
Porotic hyperostosis	0/3 (0)	17/43 (39.5)	0.2855
Enamel hypoplasias	1/3 (33.3)	26/42 (61.9)	0.5548
Cribra orbitalia	0/1 (0)	0/30 (0)	1.0000
Periostosis	0/3 (0)	8/43 (18.6)	1.0000

Notes: n^1 = number of individuals with stress marker.

N^2 = total number of observable individuals.

* = Statistically significant difference.

Table 12.2. Stress marker frequencies for combined sex, adult males, and adult females at Toqua

Stress Marker	Mound (n^1/N^2, %)	Village (n^1/N^2, %)	*p*-value
Combined sex			
Porotic hyperostosis	25/65 (38.5)	69/102 (67.6)	0.0002*
Enamel hypoplasias	18/72 (25.0)	38/99 (38.4)	0.0656
Cribra orbitalia	2/18 (11.1)	6/71 (8.5)	0.6611
Periostosis	12/81 (14.8)	38/108 (35.2)	0.0017*
Adult males			
Porotic hyperostosis	8/14 (57.1)	35/45 (77.8)	0.1293
Enamel hypoplasias	5/14 (35.7)	16/46 (34.8)	1.0000
Cribra orbitalia	1/9 (11.1)	3/34 (8.8)	1.0000
Periostosis	5/15 (33.3)	20/45 (44.4)	0.5522
Adult females			
Porotic hyperostosis	6/9 (66.7)	30/45 (66.7)	1.0000
Enamel hypoplasias	4/8 (50.0)	21/44 (47.7)	1.0000
Cribra orbitalia	1/6 (16.7)	2/35 (5.7)	0.3860
Periostosis	3/9 (33.3)	15/47 (31.9)	1.0000

Notes: n^1 = number of individuals with stress marker.

N^2 = total number of observable individuals.

* = Statistically significant difference.

Table 12.3. Stress marker frequencies for combined sex, adult males, and adult females, combined site sample

Stress marker	Mound (n^1/N^2, %)	Village (n^1/N^2, %)	*p*-value
Combined sex			
Porotic hyperostosis	25/86 (29.1)	105/192 (54.7)	< 0.0001*
Enamel hypoplasias	25/98 (25.5)	87/182 (47.8)	0.0003*
Cribra orbitalia	2/20 (10.0)	8/127 (6.3)	0.6267
Periostosis	12/102 (11.8)	56/199 (28.1)	0.0013*
Adult males			
Porotic hyperostosis	8/19 (42.1)	53/76 (69.7)	0.0246*
Enamel hypoplasias	8/19 (42.1)	35/76 (46.1)	0.7572
Cribra orbitalia	1/10 (10)	5/56 (8.9)	1.0000
Periostosis	5/20 (25)	29/76 (38.2)	0.3076
Adult females			
Porotic hyperostosis	6/15 (40)	47/88 (53.4)	0.3368
Enamel hypoplasias	5/11 (45.5)	47/86 (54.7)	0.7499
Cribra orbitalia	1/7 (14.3)	2/65 (3.1)	0.2676
Periostosis	3/12 (25)	23/90 (25.6)	1.0000

Notes: n^1 = number of individuals with stress marker.

N^2 = total number of observable individuals.

* = Statistically significant difference.

of porotic hyperostosis. When Citico and Toqua were combined, non-elites in the adult (combined sex) sample had significantly higher rates of porotic hyperostosis ($p < 0.0001$). Non-elite adult males in the combined site sample also showed a significantly greater prevalence of porotic hyperostosis than elite males ($p = 0.02$). Adult females in the combined sample did not have any significant status-based differences for porotic hyperostosis.

Status-based comparisons of cribra orbitalia prevalence rates provided no statistically significant results for either site between the adult (combined sex), adult male, and adult female subsamples. Similarly, the combined site sample did not reveal any significant differences in the rates of cribra orbitalia. Few adults overall exhibited cribra orbitalia, including no adult females at Citico.

Analysis of linear enamel hypoplasias did reveal several significant results in the comparison of elites and non-elites. In the Citico adult (combined sex) sample, the non-elites had significantly more hypoplastic defects than the elites ($p = 0.004$). At Toqua, the higher rate of enamel hypoplasias

in the non-elites than in the elites is significant only when the confidence level is 90 percent ($p = 0.07$). The combined-site adult sample also revealed higher rates of linear enamel hypoplasias in the non-elites than in the elites ($p = 0.0003$). Analysis of adult male and adult female samples at Citico, Toqua, and the combined site sample all demonstrated no significant differences between elites and non-elites.

Finally, status-based comparisons of periostosis revealed a trend similar to linear enamel hypoplasias and porotic hyperostosis. The adult (combined sex) sample at Citico, Toqua, and the combined site sample all demonstrated a significantly greater rate of pathological periosteal new bone formation in the non-elites than in the elites ($p = 0.02$, $p = 0.002$, $p = 0.001$, respectively). For all cases of periostosis, there were no statistically significant results for adult males or adult females at either site or in the combined site sample. However, despite the lack of significant results, it is important to note that periostosis was consistently more common in the non-elite samples. In particular, at Citico no examples of periostosis were found in any elite individual.

Discussion

These results provide a number of insights into the health and social stratification of late prehistoric societies in a well-defined geographic and political setting. The overall trend that emerges suggests that elites had a lower prevalence of biological stress markers than non-elites, supporting the hypothesis proposed earlier. This finding is consistent with the results of previous studies (Hatch 1976; Hatch and Willey 1974; Hatch et al. 1983). As suggested, elites likely had greater access to resources, such as meat or other high-quality foods, which resulted in better overall nutrition. Good health may also have been a predicate to social elevation, as health may have been perceived as an indicator of virtue (Smith et al. 2011). VanDerwarker (1999) used zooarchaeological remains from the Toqua site to examine feasting patterns. She has argued that feasting was predominantly the realm of high-ranking males, while females of all ranks and low-ranking males were generally excluded from feasting practices. In addition, research on dietary differences at the Citico site found significantly higher rates of dental caries and antemortem tooth loss in the village burials than in the mound burials (Betsinger and Smith 2007), which suggests that the non-elites were consuming a greater proportional quantity of carbohydrates, most likely maize. While a maize-based diet may provide ample calories, it is not nec-

essarily a nutritious diet. Better nutrition would reduce the likelihood of stress episodes leading to linear enamel hypoplasias, porotic hyperostosis, cribra orbitalia, and periostosis. While elites and non-elites at both Toqua and Citico inhabited the same general area and were thus likely exposed to similar levels of pathogens (including parasites in a common baseline environment), better nutrition among the elites would have afforded them greater resistance to infection, thereby probably synergistically decreasing the rates of linear enamel hypoplasias and periostosis. Greater consumption of meat by elites would also suggest fewer deficiencies in iron and vitamins B_{12} and B_9, which are argued to be the most probable causes of porotic hyperostosis (Stuart-Macadam 1992; Walker et al. 2009). Moreover, elites may have had differential access to therapeutic care and may also have been less likely to be involved in activities that posed health risks.

While the adult (combined sex) sample consistently provided statistically significant differences between the elites and non-elites, the lack of similarly significant results in the adult male cohort is likely due to the small size of the subsample. The elite component (mound burials) for both Citico and Toqua provided a total of 111 individuals. However, sex could be estimated for only 32 of the 111 individuals. The resulting subsample sizes of 20 males and 12 females (combined sites) were quite small. Regardless, when those without a determinable sex are included, the status differences become apparent. The lack of significant differences in the adult female component may be due, in part, to sample size issues, especially as it relates to mortuary patterning (Sullivan 2001).

The significantly higher rates of porotic hyperostosis among non-elites are likely attributable to different diets and to other factors such as parasitism due to contaminated drinking water. Elites and non-elites may have had access to the same sources of water and thus may have had similar exposure to and risk of infection. However, a better diet would have buffered the elites to some degree because nutrition plays a role in immunocompetence (Lallo et al. 1978; Larsen 2015). Combined with potential access to therapeutic or palliative care, this may have meant that elites suffered less frequently with such infections. Moreover, if porotic hyperostosis is generally reflective of a childhood condition (Walker et al. 2009), the differences between elites and non-elites may have been a function of maternal diet and weanling diet. If consumption of some foods, such as meat, differed for adults based on status (VanDerwarker 1999), then it is possible that elite and non-elite children consumed different diets as well. While Betsinger and Smith's (2007) examination of dietary differences focused on adults,

non-elite children may have also been consuming more maize than elite children, mirroring the pattern in adults. The maternal diet can also have a significant impact on the health of children as well. As Walker and colleagues (2009, 114) point out, "In populations with restricted animal food access, the risks of vitamin-B_{12}-deficiency-induced megaloblastic anemia are greatly increased for nursing infants." Pregnant and nursing women who have low meat consumption may have low vitamin B_{12} levels in their breast milk, which would reduce B_{12} levels in their children, putting them at greater risk for developing porotic hyperostosis.

The absence of statistically significant results in status-based comparisons of cribra orbitalia rates does not support a very strong correlation with porotic hyperostosis. It has been suggested that porotic hyperostosis and cribra orbitalia have a common etiology (Stuart-Macadam 1989). However, more recent research has made a strong argument that there is no direct and conclusive association between the two (Walker et al. 2009). In the skeletal samples studied in this work , porotic hyperostosis occurs much more commonly than cribra orbitalia. For example, in the non-elites of the combined-site adult sample, 54.7 percent have evidence of porotic hyperostosis, while only 6.3 percent have cribra orbitalia. These findings suggest that there may be a separate etiology for cribra orbitalia, such as scurvy, rickets, or traumatic injuries (Ortner 2003; Walker et al. 2009). If this is the case, then it is likely that vitamins deficiencies and traumatic injuries to the eye were uncommon overall and did not vary between elites and non-elites. Divergent diets may not have extended to foods that provided vitamins C and D and may have led to comparable levels of scurvy, rickets, and cribra orbitalia.

The trend that emerges from the linear enamel hypoplasia data supports the notion that non-elites were more stressed in childhood than elites. In addition to the differences in meat consumption described above, it is possible that non-elites consumed less food overall or greater quantities of lower-quality food, especially in years of drought or poorer agricultural yield. Evidence of such stress is indicated by the physical decline of Toqua as the palisades enclosed successively smaller areas of land. Schroedl (1998) asserts that large towns such as Toqua may have had to disperse their populations at intervals ranging from every 50 to every 150 years due to soil exhaustion. The rebuilding and repair of palisades and shifts in mound construction may reflect these periods of instability (Schroedl 1998). It can be assumed that the years leading up to such a population reduction and dispersal would have also been difficult as agricultural yields declined. The

reduction in agricultural foods may have more acutely affected non-elites than elites. In addition, poorer overall nutrition would have made non-elites more susceptible to infection, which could also lead to hypoplastic defects.

Finally, the significantly greater rates of periostosis in the non-elites than in the elites points to several probable explanations. As previously discussed, better nutrition in the elites would afford them more resistance to infectious pathogens. In addition, there may have been differences in exposure to parasites and other disease agents. Non-elites may have been engaged in different types of activities, used different food preparation techniques, or eaten different supplemental foods than elites, thereby compounding their risk of infection.

Conclusions

These results support the hypothesis that non-elites experienced more physiological stress and thus greater compromised health than elites in this prehistoric population from eastern Tennessee. The disparity in these stress markers is likely due to differential access to resources and superior cultural buffering mechanisms surrounding these Mississippian elites. Non-elites may have had greater exposure to sources of stress, such as parasites, that would be complicated by a poorer diet. The synergistic relationship between nutrition and infection would have compounded the effects in non-elites, leading to the higher rates of porotic hyperostosis, linear enamel hypoplasias, and periostosis. While the results of this study are consistent with earlier findings (e.g., Hatch 1976), they stand in contrast to others, most notably Powell's (1991) examination of status and health at Moundville in Alabama. She found a lack of correlation between health indicators (e.g., linear enamel hypoplasias, anemia, and infectious disease) and social status. The differences observed in these sites and at Moundville may be related to environmental pressures and soil exhaustion that likely occurred in eastern Tennessee. Archaeologists suggest that the decline in the palisaded portion of Toqua reflects these hardships (Schroedl 1998), which would have potentially impacted the non-elites more than the elites. If non-elites were consuming a greater proportion of maize in their diet, then declines in agricultural yield would have affected their diet more than that of elites. In contrast, Powell (1991, 50) asserts that at Moundville, the elites and non-elites were well provided for by the environment and the organization of the chiefdom: the elites may have been "*over*nourished but not at any real

expense to everyone else." In other words, there may have been comparable dietary and behavioral differences between elites and non-elites, but it did not impact health at Moundville, the way it appears to have done so at Toqua and Citico.

This study illustrates the need for continuing examination of the relationship between status and health, as the patterns vary across sites, regions, and cultures. This work provides a baseline study for the Tellico Reservoir location of lower East Tennessee for the Dallas phase sites that are distributed across the region. Research currently being undertaken continues to investigate various aspects of health, including stress markers, infectious disease, and diet. Collectively, such analyses will provide insight into regional patterns and variations within and between different archaeological sites regarding dimensions of social status, sex, ecology, diet, disease, and inequality in the Late Mississippian world.

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13

Center and Satellite

Settlement Hierarchy and Diet on the Late Prehistoric Mississippi Delta

NANCY A. ROSS-STALLINGS

Beginning around AD 1000, archaeological evidence indicates that some of the most hierarchical societies of North American prehistory emerged in what is today the Southeast United States. These late Prehistoric developments are associated with the Mississippian cultural phenomenon and temporal period (AD 900–1300) (Welch and Butler 2006). A research focus has emerged over the last several decades regarding the archaeological features of Mississippian mound complexes, hamlets, villages, and farmsteads and their material culture, ceremonial complexity (including what is termed the Southeastern Ceremonial Complex), mortuary practices, subsistence economy, dietary systems, and indicators of health and disease from human remains.

Various scholars have addressed the complex indicators of hierarchy in these societies, including the intricate political manifestations shown by the rise and fall of regional chiefdoms, alliances, trade networks, conflict and warfare, population pressures, and iconography (Blitz 1993a, 1999; Butler and Welch 2006; Dye 2009; Knight 2001; Muller 1997; Pauketat 1994; Powell 1988; Smith 2000). The diversity of Mississippian and Protohistoric peoples of the Southeast provide valuable opportunities to examine the consequences of social inequality and materialist models of top-down power as exemplified in the concepts of hierarchy and heterarchy.

In this chapter, I examine patterns of biological stress and oral health as related to diet between two neighboring Mississippian sites in the Central Mississippi Valley. The Hollywood site was a locally prominent mound complex, and the Flowers #3 site was one of its subordinate satellite com-

munities. Because the broader organizational features of Mississippian society helped shape complex lifestyles for its people, the work in this chapter seeks to learn if differences in diet and nutritional stress existed between these two differentially ranked settlements. In this respect, the current study offers an opportunity to synthesize archaeological and biological evidence from these sites in order to learn about the potential ways hierarchical social systems affected human life and well-being in the Late Prehistoric Southeast.

Biocultural Contexts

Ecogeographic, Cultural, and Temporal Settings

The Mississippian Cultural Area encompassed multiple river drainages, including the lower Ohio River, the Mississippi River, the Tennessee River, the Black Warrior River, the Coosa River, and the Arkansas River. Many lesser river systems opening into these drainages also were inhabited by peoples who practiced variants of Mississippian culture or were influenced to varying degrees during portions of this period by the events, cultural practices, and political economy of the Mississippian heartland. Examples of such groups were the Caddo to the west, various groups on the southern Appalachian fringes, Caborn-Welborn and their Angel predecessors in southern Indiana and its environs, and many peoples of Minnesota, Illinois, Missouri, Florida, and Oklahoma (Butler and Cobb 2012; Clay 2006; Jefferies et al. 1996; Meyers 2002; Pollack et al. 2002).

The Mississippi Delta is a geographical landform that stretches in a diamond-shaped pattern from Memphis, Tennessee, to Vicksburg, Mississippi (Fig.13.1). It is a predominately flat alluvial plain that was created by repeated flooding episodes of the Yazoo River basin system as it flowed southwest toward the Mississippi River. This system meandered and carved new channels over tens of thousands of years on the western margin of this plain. In the northern portion of the Mississippi Delta, the Tallahatchie and Yalobusha Rivers meander southward, meeting at Greenwood, Mississippi, to form the Yazoo River, which runs for 303 km. Just north of Vicksburg, the Yazoo River empties into the Mississippi River. Natural levees in the alluvial plain prevent the Yazoo River from flowing into the Mississippi River farther to the north (McNutt 1996, xii; Williams 2001).

Because of repeated flooding episodes and the presence of old channel cutoffs that also periodically flood, this alluvial plain has some of the most

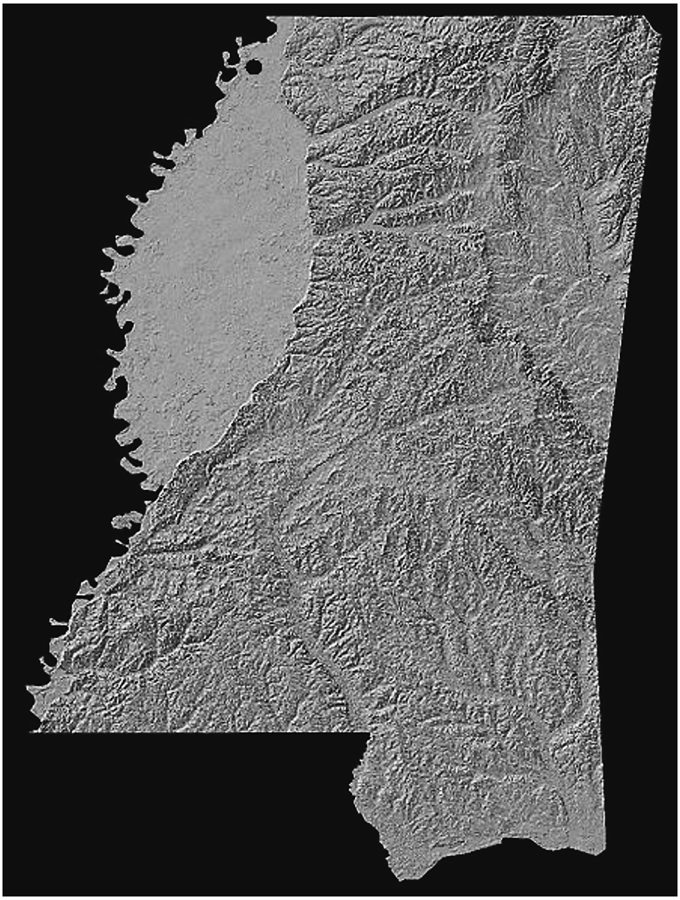

Figure 13.1. Relief map of the state of Mississippi. The delta is shown on the left; the black dot in the upper left marks the location of the sites described in the text. Figure by Todd Johanboeke.

fertile soil in the world. The old river channel cutoffs are now crescent lakes across the western portions of the delta. The Mississippi River Valley hosts a flyway for migratory birds, enriching seasonal hunting opportunities for Prehistoric inhabitants. Reconstructions of the precontact environment indicate that the delta was covered by forests and canebrakes. Swamps were dominated by cypress trees. Hardwoods, including various types of oak, hickory, pecan, black gum, and elm were located on higher ground. In areas of lower ground, trees such as tupelo gum, maple, hackberry, cottonwood, sweet gum, and other varieties of oak and elm were common. These lush microenvironments included herbaceous plants and vines that supported a varied array of aquatic and terrestrial animals, including fish, mussels, birds, large and small mammals, amphibians, turtles, and other reptiles. Rainfall was plentiful and the annual growing season was long; the current growing season lasts more than 220 days (Connaway 1984; McNutt 1996).

Predictably, this region attracted people for thousands of years before the Mississippian period began around AD 1000. The earlier Woodland period inhabitants (ca. 600 BC–AD 700) began to cluster in villages and transitioned from hunting and gathering to lifeways that used horticulture as a key component of food acquisition. By the Late Woodland/Early Mississippian transition around AD 700–1100, sites in the northern half of the delta were transitioning from hunting with atlatls to hunting with bows and arrows, maize agriculture (in the form of tropical flint), establishment of the substructure mound-and-plaza complex that featured rectangular wall-trench houses, and the introduction of shell-tempered pottery (though the retention of the older grog-tempered pottery is noted in some areas). Thus, recognizable Mississippian period cultural elements emerged and became more pronounced in the design and layout of the sites, the types of houses, in shell-tempered pottery technology, and in increasingly intensified maize cultivation (Rolingson and Mainfort 1988; McNutt 1996).

Organizational Characteristics

By AD 1350, at least some of the single mound sites in this central Mississippi Valley region had developed into significantly larger communities with multiple mounds characterized by exceedingly complex stratigraphy and developmental phases (Buchner 1996; Downs 2007; Duff 1994; Johnson et al. 2000; Neitzel 1983; Ross-Stallings 2002; Smith 1990; Starr 1997; Wesler 2001; Williams and Brain 1983). Large, complex settlements were the most visible of Mississippian and Protohistoric habitations in the Southeast. Many had multiple designated places for interments, such as at Cahokia (Pauketat 2010), the Fatherland Site in Natchez (Neitzel 1965, Figure 10), Spiro (Brown 2010), Oliver (Duff 1994), Etowah (King 2010), Moundville (Wilson et al. 2010), Obion (Garland 1992), Wickliffe (Wesler 1996), Koger's Island (Marcum 2010), Chucalissa (Childress and Wharey 1996), Town Creek (Boudreaux 2010), and Winterville (Brain 1989). Some interment clusters were in mounds, while others were in strategic or symbolically charged areas in or near plazas, sometimes associated with house clusters that may reflect separate kin groups. Bodies were also deposited in domestic settings, such as Burial 6, a small child who was interred under a house floor at the Hollywood site. In some large Mississippian sites, calibrated radiocarbon dates and ceramic seriation (Duff 1994; Franklin and McCurdy 2005; Ross-Stallings 2002; McNutt 1996) demonstrate that these burial zones continued to be used as cemeteries after some architectural elements in the sites fell into disuse. While some large sites were abandoned

over the following three centuries, many others remained inhabited more or less continuously into the seventeenth and even the eighteenth century (Buchner 1996; Childress and Wharey 1996; Connaway 1984; Krause 1996; McNutt 1996; Stallings in press; Wilson 2010).

Since the 1960s, many of the sites in the delta have been excavated on a salvage basis due to land-smoothing operations to prepare fields for rice or cotton cultivation. Within the last 30 years, salvage excavations and cultural resource management investigations prevented partial or full site destruction from highway, strip mall, housing, and casino construction projects. Unfortunately, many other sites were completely obliterated before they were adequately investigated, and untold numbers of smaller settlements were destroyed before they were ever documented.

Many of the larger temple mound sites still in existence presumably had a significant number of associated smaller satellite villages and hamlets where members of kin groups of unequal ascriptive rank resided (Marcoux 2010; Wilson 2010). In larger satellite villages, a single mound was sometimes present that served as a secondary local civic-ceremonial center in a system of regional settlement hierarchy. This center was most likely headed by an official who was under the control of a paramount chief and his decision-making body, who resided elsewhere at a large regional or primary multiple-mound center. The paramount leader was usually a genealogically sanctioned elite. These elites interacted with other regional elites in what was almost an "ethnic" identity (Dye 1995).

The power of the chiefdom was at least partially measured by the number of subordinate communities under the direct control of a chief. There were organizationally different kinds of chiefdoms on the Mississippian landscape at the same time, depending on geographic area (i.e., southern Midwest, central and lower Mississippi Valley, Atlantic Piedmont, and coastal areas) (Anderson 1996; Blitz 1993b; Jenkins and Krause 1986; King and Freer 1995; Welch 1996). It is most probable that a cycle of emerging and collapsing chiefdoms continuously occurred throughout the Mississippian period. This manifestation was marked by large mound centers constructed beside an antecedent series of small centers. A multiple-mound primary center would soon be linked in a hierarchical relationship to single-mound secondary centers. With time, retrenchment occurred as an old chiefdom collapsed into a series of small centers as fortunes and alliances shifted or when a powerful chief died (Blitz 1999). By the end of the thirteenth century and into the fourteenth century, relatively simple chiefdoms developed into complex polities in the Central Mississippi Valley. Settle-

ment organization developed into a three-tiered system and a political hierarchy in which the civic-ceremonial centers contained public space and monumental architecture. There was a significant labor investment in this process, and people's labor was at the beck and call of paramount chiefs. The interpolity system delineated ruling elites as divine and conferred combined religious and secular leadership roles (Dye 1995).

Tribute flowed in different directions. Chiefs exchanged valuable, exotic, symbolic goods, including prisoners (who sometimes became slaves), with one another to strengthen alliances, as payback for deaths in warfare, or to terminate warfare (Blitz 1993a, 1999; Dye 1995; King and Freer 1995; Morse 1990; Peregrine 1995). The chief commanded people living in his subject villages and farmsteads to provide a second type of tribute. This could include foodstuffs, goods, and services (including labor for construction of earthworks) (Jenkins and Krause 1986; Swanton 1911).

By the late fourteenth to early fifteenth centuries, larger chiefdoms had begun to subjugate smaller neighboring polities, sometimes using overt force. This opened a scenario whereby chiefs were in constant (possibly heterarchical) competition with their neighbors, forming alliances, breaking alliances, and waging war (Dye 2009). During this period, the territorial extent of a typical Mississippian chiefdom is estimated to have been from 40 km (Blitz 1999) to 90 km in radius; 90 km was probably the maximum radius of military or political control without modern communication systems (Peregrine 1995, 254–256).

But what was the lot of commoners in Mississippian societies? Spencer-Wood (2010) considers how minorities, the lower classes, and females related to different types of "power" used at all levels of society. Spencer-Wood concentrates on the Historic period and addresses primarily the influence and impact of built and altered landscapes as a backdrop for different social classes. She provides examples of interactions of those who had less power with "elites" or other classes of people who could dominate and influence those not in power. This is relatively easy to document in many Historic period societies; sources include written resources such as newspapers, court case records, census and tax records, diaries, civil and military records, satire, plays, poetry, and fiction. Those in power could use "powers over" (physical force, psychological coercion, hegemony) to coerce the lower classes to live "in their place." Conversely, those in the lower social strata, by virtue of economics, inheritance, sex, and skin color, could sometimes acquire "powers under," using their power to attempt to influence those in control. Examples of these acts include flattery, pleas for

protection, compliance (on some levels), adaptation, manipulation, malingering, resisting, and outright rebellion. Groups of the underclass could, she proposed, practice "powers with" one another by inspiring, persuading, influencing, and empowering subgroups to form alliances (Spencer-Wood 2010, 503).

In contrast, documenting the elite domination of commoners in the archaeological record can be difficult. Archaeologists and bioarchaeologists look at the characteristics of an elite mound site (i.e., exotic artifacts; mounds; plazas; larger structures; and complex layouts; indicators of feasting, larger and better cuts of meat, other dietary evidence; and better overall health status of those interred in these sites). Also, the nature of hamlet, farmstead, or satellite village sites can be defined in terms of what they lacked compared to a mound complex (i.e., fewer and smaller structures, smaller quantities or a total lack of exotic goods, less amounts of desired foods, evidence of less population aggregation, and the evidence of health status of the residents). Resistance to paying tribute, reluctance to provide labor to build more structures at a mound center, and other acts of "lack of cooperation" when elites demanded goods and services probably did occur. The complex evidence of such outcomes must be gathered by the approaches outlined above.

Swanton (1911) compiled some examples of the influence (or lack of influence) of Protohistoric era commoners on elites based on eyewitness accounts of the Spanish and French. The surviving ethnological accounts are from contacts with the Natchez to the south. Early Historic period southeastern Native American groups (i.e., Swanton 1911, 1922, 1931, 1946) and compilations of earlier accounts from de Soto's travels across the southeast in the early 1540s (Hudson 1997) are heuristically useful. They hint at day-to-day relationships between governing and religious elites and commoners in the Protohistoric, and early Historic periods. Still, they are unlikely to be an exact reflection of social relationships within earlier Mississippian groups. Also, the observers carried significant biases related to their social, political, or religious agendas.

Mississippian Bioarchaeology and Status

The Mississippian culture area is geographically large. There is wide variation in the societies in the Mississippian core areas and among adjacent regions that became "Mississippianized" to different degrees. Many theses, dissertations, books monographs, contract archaeology reports, govern-

ment publications and articles have been written about Mississippian bioarchaeology. Because of the hierarchical nature of the societies the Mississippians and Mississippianized societies created (for example, Caddo, Oliver, Fort Ancient), research has often been underscored by overt or underlying themes related to status and hierarchy.

Powell (1988) conducted one of the most prominent studies regarding skeletal relationship to social status at Moundville, a mound complex in the Black Warrior drainage of Alabama. Powell examined skeletal manifestations of health and status within the framework of what was then known about the site and politics of the Moundville chiefdom. The book was groundbreaking because it traced the social and archaeological development of the site over its 500-year occupation and addressed the changes in health issues in subpopulations by time of interment. In addition, she compared her data with contemporaneous skeletal samples from Etowah in Georgia, in Chucalissa in southwest Tennessee, in the Dallas and Hixon Phase societies in eastern Tennessee, and other contemporaneous populations (1988, 193–197). Later, Powell (1988, 1991, 2007) reexamined Moundville. Other researchers have revisited Moundville, addressing in more detail certain aspects of population stressors and status (Armelagos and Hill 1990; Funkhouser 2015; Hodge 2011; Mistovich 1995).

Additional bioarchaeological research on the relationship between status and biological stress has been conducted at Chucalissa (Childress and Wharey 1996; Lahren and Berryman 1984), Averbuch (Eisenberg 1986), Wickliffe (Matternes 2000), Toqua and various other Dallas Phase sites in Tennessee (Hatch and Willey 1974; Hatch et al. 1983; Kelso 2013; Owens 2011; Parham 1987; Betsinger, this volume), the Turner Site in Missouri (Black 1979), and the Lake George, Lyons Bluff, and Oliver sites in Mississippi (Egnatz 1983; Hogue 2007; Listi 2013; Ross-Stallings 2002).

Cassidy (1972, 1984), Goodman et al. (1984), Perzigian et al. (1984), and Rose et al. (1984), among others, have done work on the Mississippian hinterlands. Lambert (2000, 192) stated that "political centralization and large settlement size were not always the most important factors in either the severity or chronicity of diseases. Variations within this region further suggest that variables such as resource distribution, quality of arable land, microclimatic variability, and unique cultural practices influenced health and thus the quality of life in various regions of North Carolina and Virginia." In addition, work synthesizing subregions of the Mississippian area and the hinterlands has been compiled and serves as a foundation for the study of populations in the Mississippian culture areas. These publications place

bioarchaeology in the immediate context of an archaeological site, forming an invaluable starting point for researchers (Jeter et al. 1989; Hogue 2008; Rose 1999; Story et al. 1990a, 1990b; Wood et al. 1995). The overarching conclusion of these studies is that the skeletal stressors exhibited by individual Mississippian populations are present in an overwhelming number of groups but that the degree and type of stressor varies temporally, geographically, and by social status. There is no one expectation about the relationship of stressors to status in these populations. Instead, each group must be approached carefully in a particularistic, locally focused way and then placed in a context of what has been previously established regarding other Mississippian groups.

Research Hypothesis

Based on the contextual considerations for the Mississippian period in this portion of the Southeast, this chapter examines two burial samples from the Mississippi Delta. What were the biocultural impacts of a hierarchical Mississippian social system on the biology and well-being of humans south of Memphis, Tennessee? This chapter test a straightforward hypothesis: the skeletal remains of the people interred at the larger Mississippian multiple-mound site will exhibit indicators of better health than a burial sample from a contemporaneous smaller satellite village. This will be the case despite the fact that both sites are located in a virtually identical environment and had an overlapping resource base that contained the same types of abundant and nutritionally varied food resources. In this way, this study attempts to independently test archaeological data that portray strongly hierarchical differences in settlement patterns, material culture, and political power in the Mississippi Delta.

Materials and Methods

Flowers #3

The Hollywood Site (22TU500) and the Flowers #3 Site (22TU518) were located 6.5 km apart (Fig. 13.2). The Flowers #3 Site was likely adjacent to the banks of the Mississippi River.

Unfortunately, the Flowers #3 site was destroyed in 1974. The only information about the site was collected by John Connaway of the Mississippi Department of Archives and History as it was being leveled by a plantation owner. Connaway (1981) determined that the site had a small cemetery area

Figure 13.2. The locations of the Hollywood Site (22TU500) and the Flowers #3 Site (22TU518) shown on a combined USGS 7.5-minute topographic map of the Robinsonville and Tunica quads. Figure by Todd Johanboeke.

some 277 meters to the east of the village area, measuring 3 × 6 m in size. A total of six interments representing fourteen individuals were rescued. Other human remains were in very poor condition and were not incorporated into this study. Connaway observed numerous rectangular wall-trench houses arranged along an old natural levee of the Mississippi River. The houses were rebuilt from two to five times each, demonstrating a relatively long period of occupation. Connaway (1981) found that the vegetal portions of the inhabitants' diets included a mixture of cultigens and wild foods, which is consistent with Late Prehistoric Delta populations. Paleobotanical remains that were isolated from some of the salvaged refuse pits included maize, persimmon, wild bean, wild grape, sedge and knotweed seeds, and hickory and pecan shells. Chronometric date ranges cluster in the AD 1400–1600 timespan and are considered most reliable, and are additionally validated by temporal variation of ceramic wares recovered at the site which all fit confidently into a Delta chronology (Stallings in press).

The Flowers #3 burials were all secondary interments whose mortuary program involved initial decomposition above ground, either in a charnel house (Swanton 1911, 1931) or wrapped in mats or hides and placed on scaffolding. After soft-tissue decomposition, the bones were gathered and buried in bundles (Swanton 1931, 1946). Grave offerings were included in the Flowers #3 interments.

The Hollywood Site

In contrast, archaeological examination of the Hollywood Site at the base of some of the mounds demonstrated that it was occupied from the Early Woodland period (300–400 BC (McNutt 1996) into the Middle to Late Woodland periods, ca. AD 400–700 (Johnson et al. 2000; McNutt 1996). Research that was begun at the Hollywood Site in 1993 (Johnson et al. 2000; Girardino and Haley 2006; Ross-Stallings 1993, 1994; Ross-Stallings et al. 1995) determined that the old Mississippi River channel cutoff was already a crescent lake by the time the site reached its apex and became a mound center (Johnson et al. 2000). It had a broad range of floral and faunal resources (the area was populated by aquatic and terrestrial plants and animals) and ample rich field areas for horticultural activities that stretched out across the delta. It was more isolated and easier to defend than Flowers #3, which was located in a prominent location on a levee of the active Mississippi River (Johnson et al. 2000). The total site encompasses 16.2 hectares (40 acres) and is characterized by an impressive layout that has a central site area with a rectangular layout.

The largest rectangular flat-topped mounds were situated nearest the channel cutoff on the east side of the site. The remainder of the site's central area was enclosed by a series of mounds that formed the north, south, and west perimeters. Excavations indicated that within the enclosure, the lower mounds had rectangular wall-trench dwellings on them. Interments were made in a delineated burial area in the north-central part of the site, near Mound A, the largest mound. Mound A was so tall and steep that motorized equipment such as tractors could not ascend it. It was never damaged by deep plowing. Interments were also occasionally placed in house floors and in other plaza areas. The majority of intact interments that have been located to date were secondary bundle burials, just as at Flowers #3, but a few burials were extended, and one newborn infant was found interred in a vertical (standing) position. Many of the recovered remains salvaged in most areas of the site were from disturbed interments, since this site was farmed extensively for over 160 years.

The site layout is comparable to many other large multiple-mound ceremonial centers, but there is some variation in the configuration of mound center sites across the delta (Connaway 1984). The site owes its name to a ceramic type (Hollywood White) that also was the name of a temporal phase. The name is based on ceramic chronology and site layout during its Late Mississippian period ceremonial center occupation (McNutt 2008). The ceramic chronology and calibrated two sigma radiocarbon dates place its most probable Late Mississippian period occupation at AD 1400 to 1550 (Johnson et al. 2000).

The Human Skeletal Remains

Skeletal Samples

The skeletal material used in this research are tabulated in Table 13.1, 13.2, and 13.3. The Flowers #3 sample consists of 14 individuals (three adult females, two adult males, three adults of unknown sex, five subadults, and one infant). All of the individuals were either bundle interments or were represented by clusters of dentitions presented as grave goods in a bundle interment; thus, none of the individuals were complete. None of the Flowers #3 individuals had complete dentition, but 11 individuals had at least some preserved teeth. The most complete set consisted of 16 teeth and the least complete set consisted of two teeth.

The total number of individuals recovered at the Hollywood Site was 115. Of those, 16 were from intact funerary contexts (four females, three males,

Table 13.1. The Flowers #3 and Hollywood mortuary assemblages

Site	Interments, extended or bundles (n)	Individuals represented as isolated tooth clusters in primary interment (n)	Individuals represented as surface scatters (n)	Total individuals (n)	Additional individuals with crania or cranial fragments present (n)
Flowers #3	12	2	0	14	10
Hollywood	16	0	99	115	56

Table 13.2. Permanent maxillary and mandibular tooth count by tooth type at the Flowers #3 and Hollywood sites

Maxillary dentition	Flowers #3	Hollywood	Total	Mandibular dentition	Flowers #3	Hollywood	Total
LM^3	3	1	4	LM_3	3	3	6
LM^2	4	8	12	LM_2	4	8	12
LM^1	5	4	9	LM_1	6	6	12
LP^4	2	4	6	LP_4	4	5	9
LP^3	4	2	6	LP_3	5	2	7
L^C	1	6	7	L_C	3	4	7
LI^2	1	2	3	LI_2	4	3	7
LI^1	2	3	5	LI^1	0	2	2
RI^1	3	2	5	RI^1	2	1	3
RI^2	4	1	5	RI^2	3	2	5
R^C	4	3	7	R_C	4	2	6
RP^3	1	4	5	RP_3	3	3	6
RP^4	1	2	3	RP_4	6	2	8
RM^1	4	4	8	RM_1	7	6	13
RM^2	3	6	9	RM_2	4	4	8
RM^3	3	3	6	RM_3	2	3	5
Total	45	55	100	Total	66	56	122

three adults of unknown sex, three subadults, and three perinatal individuals). The rest of the remains consisted of fragmentary and incomplete bones derived from surface finds that were found and mapped across the site. Despite the fragmentary nature of the remains, some age and sex estimation was possible. At Hollywood, additional 19 surface finds consisted of

Table 13.3. Deciduous maxillary and mandibular tooth count by tooth type at the Flowers #3 and Hollywood sites

Maxillary dentition	Flowers #3	Hollywood	Total	Mandibular dentition	Flowers #3	Hollywood	Total
LP^2	1	2	3	LP_2	1	0	1
LP^1	0	2	2	LP_1	1	0	1
LD^C	2	3	5	LD_C	1	0	1
LDI^2	0	2	2	LDI_2	0	0	0
LDI^1	0	2	2	LDI_1	1	0	1
RDI^1	0	3	3	RDI_1	1	1	2
RDI^2	1	2	3	RDI_2	1	1	2
RD^C	1	2	3	RD_C	1	0	1
RP^1	1	1	2	RP_1	1	0	1
RP^2	1	0	1	RP_2	1	0	1
Total	7	19	26	Total	9	2	11

subadults, including a perinatal individual. The other surface finds corresponded to five male and two female adults. The Hollywood individuals who were excavated as interments did not tend to have complete dentition, and many of the teeth were recovered in the surface scatters.

The remains from the Flowers #3 site were excavated in the 1970s (Connaway 1981) and were examined in the lab by the author in 1991 and 1992. The Hollywood remains were analyzed as they were excavated or collected from the early 1990s to 2001. There, the author either excavated or was present when most of the skeletal remains were excavated or collected. All intact interments at Hollywood were initially analyzed in situ and all but three were examined more thoroughly in the lab. Three remaining individuals were left in situ and were reburied. Fragmentary remains that were initially identified as human (rather than faunal) were later studied in a laboratory setting.

Methods

Since the majority of the Hollywood data and all of the Flowers #3 data were collected prior to the publication of Buikstra and Ubelaker (1994), custom-made multipage burial reference forms were specifically designed for these interments. The burial analyses were part of a much larger research project conducted by the author that encompassed populations from the Early Woodland to European contact eras in the broader Mississippi Delta

region. The skeletal reference forms the author designed and used overlap significantly with the standards of Buikstra and Ubelaker and shared the same sources for methods and data collection protocols (i.e., Bass 1987). Once Buikstra and Ubelaker became available, the author was able to use their updated data collection protocols with the skeletal and dental material that had not yet been analyzed.

A 15x hand lens was used to supplement the visual examination of the skeletal and dental material in both field and lab settings. In some cases, a stereoscopic microscope was used to more closely examine some aspects of the skeletal material and teeth in the laboratory. In the laboratory, the skeletal elements were cleaned, examined, and analyzed and the resulting data was recorded on forms for each individual.

The author used standardized age and sex estimation techniques from Bass (1987), Lovejoy et al. (1985), Meindl et al. (1985), Meindl and Lovejoy (1985), and Buikstra and Ubelaker (1994). Skeletal elements from fragmentary remains that were gracile in appearance but did not have definitive female characteristics were designated as unknown, since some known adult males in Mississippian period samples from the Delta are surprisingly gracile. While these individuals were fragmentary, they added to the overall reconstruction of the health status of the population.

Since complete dentition was not present at Flowers#3 and Hollywood due to antemortem tooth loss or preservation issues, individual teeth were scored for the presence or absence of caries and enamel hypoplasias were scored by tooth count. Tables 13.3 through 13.6 describe the number of individual teeth present at each site.

The pathological conditions discussed in this chapter are defined using Buikstra and Ubelaker's (1994) protocols, supplemented by Barnes (1994), Goodman and Rose (1990), İşcan and Kennedy (1989), Jeter et al. (1989), Kelley and Larsen (1991), Ortner and Aufderheide (1991), Ortner and Putschar (1985), Rose (1999), Stini (1990), Story et al. (1990a, 1990b), Wood et al. (1995).

Dental caries are dark eroded regions of the tooth enamel that do not include the exposure of pulp chambers due to dental wear. Frequencies of dental caries are reported by tooth count rather than by individual count since so many of the teeth in this sample were loose and could not be attributed to specific individuals. Enamel hypoplasia is a deficiency in enamel thickness that may be caused by systemic metabolic stress, hereditary anomalies, or localized trauma. It is created by an insufficient secretion of enamel matrix and is distinct from enamel opacity. Systemic metabolic

stress usually produces defects in matching anterior tooth antimeres. These defects produce incomplete enamel crowns and thus indicate age at the time of an insult (Buikstra and Ubelaker 1994, 56). Localized trauma was ruled out, since the appearance and location of the lesions were consistent across the sample; dental trauma is more random. While hereditary anomalies could not be completely ruled out, they have never been identified in prehistoric Southeastern Native American enamel hypoplasias. Porotic hyperostosis is an abnormal porosity of the cranial vault or cranial orbits that are thought to be the result of an anemic response resulting from a hypertrophy of blood-forming tissue in the vault. Because lesions resulting from rare hereditary anemias are morphologically distinct (Buikstra and Ubelaker 1994), the lesions in this sample are most likely attributable to chronic nutritional deficiencies, synergisms with infection, or parasitism (see also Larsen 2015). These lesions were also inconsistent in appearance or location with scurvy or rickets (Ortner and Putschar 1985; Ortner et al. 1999; Ortner et al. 2001; also Geber and Murphy 2012; Brickley and Ives 2006; Klaus 2014).

Results

The skeletal material from the Hollywood Site demonstrates strong differences relating to biological stress and health status from the skeletal material at the Flowers #3 Site (Ross-Stallings 1993, 1994, 1998; Ross-Stallings et al. 1995). An appreciably higher prevalence of dental caries scored on individual teeth was found in the individuals at Flowers #3. Poor preservation was the reason some of the teeth were missing but in other cases, people endured extensive antemortem tooth loss. While advancing age is certainly a factor in tooth loss, it was probably not a strong influence in the Flowers #3 sample because most of the individuals who lost anterior and posterior before they died were in their twenties at the time of death.

Dental decay was a notable problem for the people in the Flowers #3 sample. The individual with the most dental caries had nine lesions (though only 25 percent of his dentition was preserved) across multiple teeth (the rest were missing at time of death). One person with only two preserved teeth had two dental caries on each of these teeth. Only five people of the eleven with at least some teeth had no caries, and three of those were young children with unerupted teeth. Of the two adults with preserved teeth that had no dental caries, large amounts of the dentition had already been lost at the time of death. One of the individuals had only three teeth, and the

Table 13.4. Distribution of dental caries in permanent teeth at the Flowers #3 site

Maxillary dentition	Total number of teeth	Teeth with one or more caries present	Mandibular dentition	Total number of teeth	Teeth with one or more caries present
LM^3	3	2	LM_3	3	1
LM^2	4	2	LM_2	4	2
LM^1	5	1	LM_1	6	3
LPM^4	2	0	LP_4	4	0
LPM^3	4	0	LP_3	5	0
L^C	1	0	L_C	3	0
LI^2	1	0	LI_2	4	0
LI^1	2	0	LI_1	0	0
RI^1	3	0	RI_1	2	0
RI^2	4	0	RI_2	3	0
R^C	4	0	R_C	4	0
RP^3	1	0	RP_3	3	0
RP^4	1	0	RP_4	6	1
RM^1	4	0	RM_1	7	3
RM^2	3	1	RM_2	4	1
RM^3	3	1	RM_3	2	1
Total	45	7	Total	66	12

other had eight teeth. Table 13.4 details the numbers of carious teeth at the Flowers #3 Site. No deciduous teeth were affected by dental caries at the Flowers #3 Site.

The Hollywood population was markedly different in this respect. Surprisingly, only nine of 127 teeth excavated in features or collected from the surface collected had dental caries. Of those, two were from subadults and seven were from adults. Only one adult had more than one carious tooth. Table 13.5 tabulates the nine teeth with caries found at the site.

Enamel hypoplasias were observed at both sites (Tables 13.6 and 13.7), but the frequency of defects was markedly higher at Flowers #3. Enamel hypoplasias were generally located on anterior teeth. Of the individuals

Table 13.5. Distribution of dental caries in permanent teeth at the Hollywood site

Burial number	Sex/Age	Location	Tooth	Dental arcade	Side
2A	M/24–30	Interment	3rd Molar	Mandible	Right
74A	M/Adult	Interment	2nd Molar	Maxilla	Right
S 17	Unk./10–11	Surface	Decid. Canine	Maxilla	Left
S 18	Unk/10–11	Surface	Perm. 1st Molar	Maxilla	Left
S 58	Unk/Adult	Surface	1st Molar	Mandible	Right
S 63	M/25+	Surface	2nd Molar	Mandible	Left
S 76A	M/Older	Surface	3rd Molar	Maxilla	Right
S 76A	M/Older	Surface	Lat. Incisor	Mandible	Left
S 79	Unk/20–25	Surface	2nd Molar	Maxilla	Left
n = 8			n = 9 teeth		

with at least one tooth (n = 12), nine (75 percent) had enamel hypoplasia on at least one of the anterior preserved teeth and most (n = 7) had defects on multiple preserved teeth. The position of defects on the tooth crowns and the type of teeth with this lesion indicated that these kinds of metabolic stressors generally tended to occur during the earlier portions of childhood. Both adult males and females were affected by enamel hypoplasia. The third female had no preserved teeth. All three adults of unknown sex with anterior teeth had enamel hypoplasias. While these are admittedly small numbers, the sex ratio for adults with enamel hypoplasia was the same.

At the Hollywood Site, the frequency of enamel hypoplasias was lower. The prevalence among formal interments was very low; only two of seven individuals with preserved anterior teeth exhibited enamel defects. However, one child exhibited enamel hypoplasia in its deciduous dentition. Among the surface finds, including isolated teeth (n = 28), only six exhibited hypoplasias. Thus, taken together, of the 35 people with dentition that could be scored, only eight (22.86 percent) were affected by enamel defects. However, five had enamel hypoplasia on more than one preserved tooth. As with the Flowers #3 sample, the period of early childhood was when enamel hypoplasias tended to form on teeth. No one in this sample exhibited an enamel hypoplasia on a third molar. The sex ratio at Hollywood for the prevalence of enamel hypoplasia included one male and one female of a total adult subsample of three males and four females.

Porotic hyperostosis differed by sex and by site. Table 13.2 shows the number of individuals at the two sites with observable cranial elements.

Table 13.6. Distribution of enamel hypoplasias in permanent teeth at the Flowers #3 and Hollywood sites

Flowers # 3 maxillary dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias	Flowers #3 mandibular dentition	Total number of teeth	N_{Teeth} w/enamel hypoplasias	Hollywood maxillary dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias	Hollywood mandibular dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias
LM^3	3	1	LM_3	3	1	LM^3	1	0	LM_3	3	0
LM^2	4	0	LM_2	4	0	LM^2	8	0	LM_2	8	0
LM^1	5	0	LM_1	6	0	LM^1	4	0	LM_1	6	0
LP^4	2	1	LP_4	4	1	LP^4	4	0	LP_4	5	0
LP^3	4	0	LP_3	5	0	LP^3	2	1	LP_3	2	0
L^C	1	1	L_C	3	0	L^C	6	3	L_C	4	4
LI^2	1	0	LI_2	4	1	LI^2	2	1	LI_2	3	0
LI^1	2	2	LI^1	0	0	LI^1	3	1	LI^1	2	0
RI^1	3	3	RI^1	2	1	RI^1	2	1	RI^1	1	0
RI^2	4	3	RI^2	3	3	RI^2	1	1	RI^2	2	0
R^C	4	3	R_C	4	3	R^C	3	2	R_C	2	1
RP^3	1	0	RP_3	3	0	RP^3	4	0	RP_3	3	1
RP^4	1	0	RP_4	6	0	RP^4	2	0	RP_4	2	1
RM^1	4	0	RM_1	7	0	RM^1	4	1	RM_1	6	1
RM^2	3	0	RM_2	4	0	RM^2	6	0	RM_2	4	0
RM^3	3	1	RM_3	2	1	RM^3	3	0	RM_3	3	0
Total	45	15	Total	66	11	Total	55	11	Total	56	8

Table 13.7. Distribution of enamel hypoplasias in deciduous teeth at the Flowers #3 and Hollywood sites

Flowers #3 maxillary dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias	Flowers #3 mandibular dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias	Hollywood maxillary dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias[a]	Hollywood mandibular dentition	N_{Total}	N_{Teeth} w/enamel hypoplasias
LP^2	1	0	LP_2	1	0	LP_2	2	0	LP_2	0	0
LP^1	0	0	LP_1	1	0	LP_1	2	1	LP_1	0	0
LD^C	2	0	LD_C	1	0	LD_C	3	1	LD_C	0	0
LDI^2	0	0	LDI_2	0	0	LDI_2	2	1	LDI_2	0	0
LDI^1	0	0	LDI_1	1	0	LDI_1	2	1	LDI_1	0	0
RDI^1	0	0	RDI_1	1	0	RDI_1	3	1	RDI_1	1	0
RDI^2	1	0	RDI_2	1	0	RDI_2	2	1	RDI_2	1	0
RD^C	1	0	RD_C	1	0	RD_C	2	1	RD_C	0	0
RP^1	1	0	RP_1	1	0	RP_1	1	1	RP_1	0	0
RP^2	1	0	RP_2	1	0	RP_2	0	0	RP_2	0	0
Total	7	0	Total	9	0	Total	19	8	Total	2	0

[a] All of the maxillary teeth with enamel hypoplasia are from one individual.

The lesions were common in the Flowers #3 sample. Of the nine individuals at the site with cranial vaults, six were affected by lesions. All of the lesions were inactive at the time of death. The two children had no preserved cranial fragments that could be scored. Two of the adult females, both males, and an additional young adult of unknown sex were affected.

In contrast, of the individuals that could be sexed at Hollywood, none of the adult males or females exhibited porotic lesions of the cranium. None of the children exhibited lesions, and affected bones were absent among the parietal and occipital cranial fragment surface finds. Two perinatal infants exhibited this condition, while a third perinate (a surface find with a number of cranial elements) did not. The two infants showed large, active lesions on the parietal bones.

Discussion

Small sample sizes and skewed sample structures are the perennial bane of most bioarchaeological analyses and may lead to problematic comparisons. One way to overcome such problems is a deep contextualization of skeletal data in local biocultural and archaeological data. In this case, the patterns of dental caries, enamel hypoplasias, and porotic cranial lesions show what appear to be potentially stark differences between the large, multiple-mound political and religious center of the Hollywood site and the much smaller, neighboring contemporaneous Flowers #3 Site.

As a satellite village, the functions of the Flowers #3 Site were at least two-fold. It was a source of labor for building mounds and other structures at the Hollywood Site and it was a source of the tribute that was paid to the political and religious elites at certain periods of the year. Since the environment was essentially the same at both of the sites, identical flora, fauna, and cultivars could have been exploited at both locations.

However, based on the differing patterns of individuals exhibiting dental caries, enamel hypoplasias, and porotic hyperostosis lesions at the two sites, the biological stressors of the people occupying the sites appear to have been different. One working hypotheses is that the inhabitants of the Flowers #3 village were pressed into service to provide the Hollywood Site with tribute payments in the form of higher-quality foods, leaving the inhabitants of the Flowers #3 Site to consume only a portion of the food sources they gathered, cultivated, hunted, fished, or collected. The physical environment, as noted earlier, included a wide variety of riverine, marsh, and terrestrial plants and animals that were available for long periods of time

over the course of a year. In the spring and fall, the location was a flyway, which added opportunities to obtain additional avian sources of protein.

The tendency for dental caries to form is intertwined with a diet heavy in foods composed of sugars and starches, and the diet at both sites was heavy in such foods. The larger issue is why the people buried at Flowers #3 exhibited higher frequencies of dental caries, with greater numbers of teeth affected, than the Hollywood individuals. This finding may be an artifact of preservation issues, but a low number of carious teeth in a Mississippian sample is unusual.

One of the foods traditionally associated with Mississippian populations is corn (maize). Archaeological evidence of maize intensification in this region began ca. AD 1200 and continued into the Historic contact period (Connaway 1984; Kidder 1990). However, other available foods, such as certain beans, squash, maygrass, and other starchy seeds would have contributed to a diet high in simple starches. It is interesting that males at the Hollywood Site exhibit more dental caries (See Table 11.8); females in agricultural cultures tend to have greater frequencies than males (Larsen 2015). Corn is regarded as a food that the Mississippian political elites would consume only occasionally (Kidder 1990, 10). Thus, if corn was being grown in large quantities, how much was allocated to mound centers and how much would have been retained for consumption in the surrounding villages? Protein-rich foods, such as the haunches of deer, large fish, snapping turtles, turkey, geese, and ducks, would all be associated with feasting. In keeping with Mississippian paramount chiefdoms, the elite at the Hollywood Site most likely requested tribute at specific times of the year for annual feasts and special events. Swanton (1911, 1931, 1946) lists ethnographic accounts from large numbers of the southeastern groups living in what is now the state of Mississippi and the Mississippi Valley that were still practicing both extensive hunting-gathering and horticulture in the sixteenth and seventeenth centuries. Unpublished faunal analyses by Ross-Stallings (n.d.) demonstrates that at the Hollywood Site, elites and others who dined at the site enjoyed a diverse array of terrestrial and aquatic-based fauna, including large cuts of deer, other mammals, turtle, birds, and fish. These foods provided excellent protein sources and served as a potential foil against high consumption of the maize, which many Mississippian groups across the lower Midwest and Southeast indeed consumed.

Blitz (1993b) notes that this type of resource distribution can be viewed as local mobilization involving the movement of foodstuffs, especially maize and venison, from individual households to a local center. This was

a ritual cycle that was coordinated by an official called a civil chief. Blitz (1993b) bases this inference on ethnographic accounts such as those found in Swanton (1946, 379–381). Blitz also notes these feasts could occur frequently; in the case of the Natchez, they occurred monthly (Swanton 1946). This would certainly put the people in satellite villages on a regular notice for tribute. Blitz (1993b) also comments that as time passed, the size of the polity expanded and the degree of social ranking increased. Hence, it is probable that the mobilization of resources would have become ever more coercive.

It must be noted that not all satellite villages in Mississippian societies appeared to have paid tribute to associated mound centers. In Rucker's Bottom, a satellite village of the Rembert Site in the South Carolina Piedmont (AD 1300–1450), the human skeletal sample demonstrated good overall skeletal health and no evidence that protein-based tribute was leaving the site. Zooarchaeological analyses from the Rucker Site reached the same conclusion (Anderson 1996, 183).

While enamel hypoplasias of the anterior teeth were observed at both sites under study here, higher proportions were found on individuals from Flowers #3. The crude prevalence of people with enamel hypoplasias at Flowers #3 (75 percent) contrasts with the prevalence among individuals at Hollywood (23 percent), indicating that even in early childhood, individuals at the Hollywood site had access to either more or high-quality foods or experienced a better overall health status (i.e., less severe or chronic illness and lower parasite loads). It must also be noted that one child at the Hollywood Site contributed all eight of the maxillary deciduous teeth exhibiting enamel hypoplasia, perhaps indicating that the child was an outlier for health status in this population. At both sites, most hypoplasias developed between the ages of three and seven years. This was probably the time when children were transitioning to an adult-type diet and were not receiving adequate combinations of nutrients for their growth and development, particularly if they tended to live in non-elite villages.

Differing patterns of porotic hyperostosis are present in the two skeletal samples. Of the nine Flowers #3 individuals with crania, six (75 percent) were affected by this condition. This included two of three females, both of the males, one adult of unknown sex, and one child. The infant (aged six to nine months) was not affected. At Hollywood, none of the adult males, females, or children exhibited lesions. Walker and colleagues (2009) argue that the iron-deficiency anemia hypothesis is inconsistent with hematological research. They suggest that hemolytic and megaloblastic anemias

are the cause of these cranial lesions. While Rothschild (2012) and others echo Walker and colleagues' thesis, there have also been counterarguments, including those of McIlvaine (2013) and Oxenham and Cavill (2010). Rothschild suggests that multiple etiologies, including parasitic infection, work in concert with other issues such as population density and low socioeconomic status (also see Klaus and Tam 2009). Long-term habitation in village sites would greatly increase parasite loads and the number of parasite-carrying rodents attracted to garbage and food storage areas, among other factors.

McIlvaine (2013) observes that vitamin B_{12} deficiency and iron deficiency tend to co-occur in contexts marked by poor sanitation. This leads to parasitic infestations, causing diarrheal diseases that initiate intestinal bleeding and nutrient loss from the intestines (as modeled by Klaus and Tam 2009). This, in fact may fit the conditions at the Flowers #3 site, and indeed Walker et al. (2009, 120) address the topic of vitamin B_{12} deficiency.

Folate deficiency is another possible etiology for the present of the cranial lesions. Ross-Stallings (2006) examined axial skeletal anomalies in a sample of 497 interments from a large sample of 36 sites in 13 counties in Mississippi. The subsample of people from these sites with adequately preserved lower vertebral columns and bony sacra was 105, or 21 percent of the total (Ross-Stallings 2006). The author has noted the presence of what appears to be a genetic predisposition to anomalous lower back development, including a failure of two or more sacral elements to fuse by young adulthood. The inference that this anomaly may be genetic is demonstrated at north Mississippian sites such as Austin, Baker's Creek Mound, Bonds, Granada Lake Mound, Humber, Oliver and 22TL1131, which all have one or more individuals from burial clusters in delineated cemeteries who displayed unfused sacral elements. Two unfused bony sacra were observed at Flowers #3. None were noted at Hollywood. Other observed anomalies in these sites include sacralization of the fifth lumbar vertebra, spina bifida, and spina bifida occulta. Genetic testing in modern populations has shown that the majority of neural tube defects are associated with specific population groups and with geographical regions where genetic variants are either identified or inferred (Rampersaud et al. 2006; Rozen 2006).

However, there appears to an environmental trigger in the expression of these genes: lowered absorption of folates during early ontogeny. When a diet is poor in folate, there may be a certain threshold at which some women will not be able to metabolize adequate folate to prevent a fetus from developing a neural tube defect. If this was the case on the Mississippi

Delta, then it is possible that some segments of the delta populations over time suffered from chronic folate deficiencies. Folate, vitamin B_{12}, and vitamin C can be destroyed by simmering (food was commonly simmered in pots in the Mississippian and Protohistoric periods). Perhaps the combination of differential access to fresh foods rich in these nutrients and cooking techniques led to the axial abnormalities and to some of the lesions seen on the crania at Flowers #3 and other sites on the Mississippi Delta from the Late Prehistoric and Protohistoric time periods.

Given these issues, it is possible to propose that porotic hyperostosis lesions at Flowers #3 may have been the result of a combination of vitamin B_{12} deficiency and probable parasitic infections. This conditions could have contributed to the cranial lesions present on the two newborn infants buried adjacent to each other at the Hollywood Site. These infants were full term, but if they were born alive, they did not survive very long. One possibility is that their mother(s) endured severe nutritional stress during pregnancy. Another is, as Walker et al. (2009) suggest, that these babies were genetically predisposed to develop an atypical pernicious form of anemia that does not commonly occur in southeastern Native American populations.

Conclusions

While sample sizes are small and comparisons are tentative, the data point to the conclusion that population at the mound center of Hollywood enjoyed better nutrition and lived in an overall better biocultural environment than their satellite village counterparts at Flowers #3. The people interred at the Flowers #3 Site appear to have consumed a nutritionally inferior diet over certain parts of their life, especially during childhood, to the diet the Hollywood inhabitants had access to. While people are mobile and some could have been raised in one location and buried in another, the evidence suggests that these two groups had a structured differential access to dietary staples even though they lived in proximity to each another.

Flowers #3 was only one of possibly many satellite villages and hamlets that were under the control of this particular mound center, and it may not necessarily represent all the possible biocultural and economic relationships between Mississippian centers and their individual satellites. These findings provide key observations and working hypotheses for future studies of human remains in terms of sociopolitical hierarchy and settlement patterns in the Mississippian world. However, because of accelerated site

destruction on the delta and bone preservation issues that sometimes occur in this region, this study was a rare opportunity to examine skeletal material from contemporaneous satellite and mound-center populations in the Late Mississippian period. The race is on to salvage and protect as many of these archaeological sites as possible before even more are destroyed.

The marked differences in observed biological stress patterns between the contemporaneous people at the Hollywood Site and Flowers #3 helps shed light on life in a complex Late Prehistoric hierarchical society of the southeastern United States. The effects of power, political influence, conflict, social debts, religious beliefs, and differential redistribution are exemplified in these Mississippian period groups on the Mississippi Delta and across the Southeast. While groups in different geographical subareas and in the fringe areas of the Southeast exhibited a varying array of elements of hierarchical Mississippian period society, the differences observed here demonstrate the potentially meaningful effects hierarchical societies had on their citizens, particularly those who were at the lower rungs of the polity.

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14

Across a Spectrum of Inequality

Hierarchy, Health, and Culturally Sanctioned Violence in the Precontact U.S. Southwest

RYAN P. HARROD, DEBRA L. MARTIN, AND MISTY FIELDS

Hierarchy and social complexity have a direct effect on the lives of people in a society. Human skeletal remains offer an especially effective medium for revealing this complexity because they offer a record of differential biological stress, nutritional deficiencies, unequal workloads, and frequency of traumatic injuries experienced during an individual's lifetime. Bioarchaeological approaches that identify hierarchy in the past, however, must incorporate more than just the bones. Placing skeletal remains back into their archaeological context is crucial for reconstructing individual, household, village, and regional relations. When viewed in their cultural contexts, evidence of skeletal pathology and trauma can provide insights into the development of sociopolitical power relations. For example, individuals who used violent means to gain or maintain social status and control of resources (e.g., food, labor, or goods) can be differentiated from the recipients of that form of social control.

The aim of this chapter is to illustrate possible relationships between social domination, health, and violence in complex societies. This focus provides important information on the origin and evolution of social stratification and the frequently violent means of enforcing and maintaining inequalities. However, in the study of past populations, bioarchaeological evidence relating to sociocultural differences has many interpretive complexities. Previous studies have used patterns of skeletal pathological conditions in conjunction with archaeological context (e.g., burial position or presence and type of grave goods) to examine how social stratification could have affected past human health and well-being (Ambrose et

al. 2003; Danforth 1999; Goodman 1998; Martin et al. 1991; Martin et al. 2001; Powell 1988; Powell 1991; Rathburn and Scurry 1991; Steckel and Rose 2002; Schepartz et al. 2009; White et al. 1993; Wright 2006). These studies demonstrate that there is often a relationship between health, access to resources, and social status.

The different ways scholars conceptualize status further complicates the issues. For example, Schepartz and colleagues (2009, this volume), who conducted a comparative study of mortuary style (tombs, pits and graves) and health indicators (age at death, dental caries, and antemortem tooth loss) of the Mycenaeans of Pylos, found poorer dental health in individuals from tombs and among females overall, suggesting that dietary differences and lower status were socially constructed.

In another example that highlights a different definition of status, Goodman (1998) tested a series of hypotheses about differential access to resources over time in a series of skeletal samples from the American Midwest. He hypothesized that as more complex economic systems focused on trade and regional political relationships developed, populations living outside political centers would experience negative health impacts. At Dickson Mounds, Goodman examined a range of health indicators including long-bone growth, defects in tooth enamel, porotic hyperostosis, infection, traumatic injury, and degenerative joint disease lesions (1998, 157). The data suggested increases in morbidity and early mortality over time as the local populations became increasingly marginalized and as economic and political coercion increased from the larger ceremonial centers. He was able to demonstrate that people at Dickson Mounds and especially at Larsen site (regional centers in the Middle Mississippian Valley) were forced to trade food they would otherwise have consumed in order to obtain exotic and symbolic (nonedible) items (Goodman 1998, 162).

Goodman's work also noted an increase in trauma for the Mississippian groups in hinterland territories, and in this study, skeletal trauma is emphasized as a crucial variable in measuring the impact of socioeconomic inequality. When evidence of trauma on the bone is viewed in its cultural contexts, it can provide insights into the development of sociopolitical power relations in which high status individuals came to dominate others through violent means (Martin et al. 2012). From a strictly Darwinian perspective, violence is understood as a biological propensity that is a complex outgrowth of competition among organisms for differential reproduction and survival. This notion, however, is too simplistic. It fails to adequately explain the range and variability in violence expressed across temporal and

spatial realms (Ferguson 2011). Culturally sanctioned uses of violence are often motivated by particular kinds of ideologies associated with power (i.e., who has power and who does not) (Whitehead 2004). Thus, questions that arise surrounding the association between violence and hierarchy include these: Can bioarchaeology be used to identify patterns of violence related to the development of social stratification? What insights can be gained about the co-occurrence of escalating violence and increasing social hierarchy?

Background to Understanding the Bioarchaeology of Hierarchy

This chapter explores bioarchaeological evidence of violence and hierarchy in the Precontact U.S. Southwest using a model based on prior work by the authors (Harrod 2013; Martin et al. 2010). In general, the approach combines context obtained from archaeological settings (e.g., site layout, location, landscape) and burial treatments (e.g., burial position and grave goods) with osteological data on trauma (e.g., antemortem and perimortem trauma) and health indicators (e.g., stature, osteomyelitis, porotic hyperostosis, enamel hypoplasia, and antemortem tooth loss). These combined indicators have proven useful in differentiating the "haves" from the "have-nots" in terms of how social stratification affected past human health and well-being (see for examples, Cohen and Armelagos 1984; Cohen and Crane-Kramer 2007a; Martin et al. 2012; Powell 1988; Powell et al. 1991; Steckel and Rose 2002). By creating empirical links between trauma, violence, and cultural processes, this chapter provides insight into the human propensity for constructing and legitimizing violent cultural scripts that play out in the lives and deaths of individuals.

Violence and Hierarchy in the Precontact U.S. Southwest

In our view, complex social organization increasingly became the major glue that held the Ancestral Puebloans in the precontact U.S. Southwest together. At the same time, it pulled this society apart. In this chapter, we identify the increasing complexity in the Southwest as a hierarchy, although Harrod (2012, 2013) has suggested that the development of regional system of leadership does not necessarily mean that the cultures in that region were completely hierarchical in nature. It is possible that a hierarchical society may have featured heterarchical configurations in hierarchical lineages (Harrod 2013, 84). Whatever the configuration of this complex society, some sort of centralized control would have allowed the Puebloan

people to contend with the vicissitudes of an agricultural lifestyle in a climatically unstable environment.

The growing complexity in this region was both a consequence of and was supported by violence. However, it is crucial to acknowledge that complex societies rely on both violence and cooperation, and that the latter is arguably the more important interaction (Harrod and Martin 2014). Yet violence is often recorded on the body, either in the form of trauma (direct violence) or health disparities (structural violence) (Klaus 2012; Pérez 2012). This chapter focuses on identifying patterns of traumatic injury, specifically recording the distribution of healed antemortem and perimortem injuries (Ubelaker and Adams 1995; Sauer 1998). The traumatic injuries of greatest interest in this project were blows to the head, both lethal and nonlethal. These blows are usually the result of blunt force trauma.

Health and Hierarchy: Forms of Evidence

As the field of paleopathology has developed, there has been a vast diversity of projects that document evidence of violence and biological stress and the morbidity of past populations. Many skeletal markers can be evaluated to provide an indication of overall health. The forms of evidence considered in this chapter include measures of stature, reconstruction of robusticity, and the identification of porotic hyperostosis, cribra orbitalia, and entheseal development.

Stature and robusticity are useful for understanding nutrition because they provide clues to the types and amount of food people had access to and the biological stress they experienced during their lifetime (Mummert et al. 2011). Stature is a well-established means of identifying whether particular people may have had better nutrition and if their growth potential was achieved (Auerbach 2011; Gunnell et al. 2001; Huss-Ashmore et al. 1982; Komlos 1995; Lewis 2002; Steckel 1995). The stature estimations in this project were derived from maximum lengths of the femur and tibia. The formula for reconstructing stature relied on Genovés (1967) since the samples used to generate the formula have been shown to be the most comparable to populations in the Southwest (Auerbach and Ruff 2010).

Robusticity, or the general size and shape of long bones, is a beneficial measure for determining load-bearing changes to the extremities. This aids in identifying differential patterns of physical activity and how long-term biomechanical loading of force optimized bone strength and form throughout an individual's lifetime (Cope et al. 2005; Pearson 2000; Ruff

2008). Robusticity indices were reconstructed from whole-bone measurements of the humerus and femur following standard methods (Bass 2005; Buikstra and Ubelaker 1994; Cole 1994).

Porotic hyperostosis and cribra orbitalia are morphological syndromes of the cranial vault that are indicators of nutritional stress during childhood (Steinbock 1976, 244; Walker et al. 2009, 119). The etiology of these pathological lesions has been highly debated ever since Welcker (1885) initially described cribra orbitalia over 130 years ago. Several possible nutritional deficiencies have been identified as potential contributors to this morphological syndrome, including insufficient dietary intake of iron, protein, vitamin C, vitamin A, or pantothenic acid. Steinbock (1976), who examined research on primates, figures recorded by the World Health Organization, and paleopathological analysis (Carlson et al. 1974; Hooton 1930; Saul 1972) in a multifactorial approach, found that the primary factor responsible for cribra orbitalia was iron deficiency. For decades, a lack of iron was the accepted cause. More recent research, however, indicates that poor iron intake may not account for the development of cribra orbitalia or porotic hyperostosis (Rothschild 2012; Walker et al. 2009). Walker and colleagues (2009) suggest that these conditions are a result of hemolytic or megaloblastic anemias, while Cohen and Crane-Kramer (2007b) suggest that scurvy could just as likely lead to the development of these pathologies. A recent journal issue edited by Crandall and Klaus (2014) offers potential methods for differential diagnosis of such lesions. Here, the presence or absence of cribra orbitalia and porotic hyperostosis relied on morphological descriptions provided by Aufderheide and Rodríguez-Martín (2003) and Ortner (2003).

Bioarchaeologists also use changes to the bone at muscle insertion sites (i.e., entheses) to infer the amount, type, and possibly even the duration of habitual labor patterns of individuals. Over time, the mechanical strain can cause plastic modification and hypertrophy of the attachment site, resulting in morphological abnormalities known as enthesopathies. Anthropologists commonly refer to these as muscle stress markers, occupational stress markers, or musculoskeletal markers (Benjamin et al. 2006; Capasso et al. 1999; Jurmain et al. 2012; Mariotti et al. 2007; Villotte et al. 2010). In a vertical hierarchical social system, enthesopathies provide a way to identify possible subaltern members of a society who performed more labor than others in the society. Mariotti and colleagues (2007) provide a detailed scoring system for recording entheseal development on a scale of 1 (low to

medium development) to 3 (very high development). Criteria constructed by Capasso and colleagues (1999) were used when a change was identified as either present or absent.

Methods for identifying violent skeletal trauma rely on forensic and clinical research (Berryman and Symes 1998; Brink 2009; Galloway 1999; Guyomarc'h et al. 2010; Haglund and Sorg 2002; Hannon and Knapp 2006; Merbs 1989; Walker 1989; Wedel and Galloway 2013). The depth, placement, severity, and location of head wounds may also suggest a variety of objects that could have been used.

Case Study: Elites at Chaco Canyon and Captives in the La Plata Valley

The ancient southwestern portion of the United States is an ideal place to examine trends in hierarchy, health, and violence because of the unique developments of complex cultures in the region. The U.S. Southwest is home today to a number of indigenous people, referred to as the Pueblo Indians, who have lived in the region for over 1,000 years. Their ancestors dwelled in adobe homes in communities spread across all of New Mexico and parts of Colorado, Utah, and Arizona. A growing body of archaeological research been conducted regarding Puebloan peoples. These studies have revealed that the spatial layout and construction of many of the sites in the region are consistent with a system of social stratification, inequality, and conflict. More recently, archaeological and bioarchaeological reconstructions of some of the mortuary contexts have lent support to the idea that there is evidence of higher- and lower-status individuals among the Ancestral Pueblo in the San Juan Basin (Harrod 2012; Lekson 2009; Plog and Heitman 2010).

The Colorado Plateau was home to the majority of Ancestral Pueblo people from the tenth to thirteenth centuries. Over the centuries, a series of changes in environmental conditions and regional social organization took place. Some of the consequences of the variable nature of this period were a series of migration events and fluctuations in population density. Of note are several large population centers that rose and declined (e.g., Chaco Canyon, Aztec Ruins, and Mesa Verde). By the fourteenth century AD, a mass exodus out of the area had led to widespread regional depopulation (Lekson and Cameron 1995; Lipe 1995).

On the Colorado Plateau, violence appears to have increased at key sites across the region when social stratification and hierarchy developed. Em-

ber and Ember (1992) argued that resource insecurity and unpredictability and socialization to fear are significant predictors of increased conflict and warfare. This "fear factor" likely played an important role in the development of hierarchies in the region, as data from dendrochronology have indicated numerous episodes of prolonged drought (Benson et al. 2007; Dean and Doyel 2006; Douglass 1929). The fluctuating climate would have meant that groups had to deal with the fear of recurring droughts along with episodic resource instability. Thus, heightened vigilance to protect limited resources could have intensified conflict and augmented social stratification. The bioarchaeological record reveals increased conflict in the region in the types of violence found on the skeletal remains of Puebloan people. Evidence for violence identified on the remains includes injuries produced from interpersonal conflict, raiding, lethal trauma, and massacre events (see. for example, Billman et al. 2000; Flinn et al. 1976; Harrod 2012; Martin 1997; Martin et al. 2010; Osterholtz 2012; Potter and Chuipka 2010; Reed 1949; Turner and Turner 1999; Walker 2008; White 1992). In addition to violent skeletal trauma, there is evidence in the archaeological record of an increase in raiding or warfare that might have led to a persistent fear of attack (see for examples, Crown and Nichols 2008; Kuckelman 2006; LeBlanc 1999; Rice and LeBlanc 2001; Wilcox and Haas 1994).

Bioarchaeological investigations from two southwestern sites help illustrate contrasting sides of the spectrum of sociopolitical hierarchy. They demonstrate how violence can be a tool for making highly visible statements about power and social status. One example is drawn from a decade of work conducted in the La Plata River Valley in northern New Mexico, where captives were obtained, subdued, and worked to the bone, so to speak. This is a community where the social status and wealth of certain members clearly differentiated them from the captors. The other example is taken from Chaco Canyon, a vast ceremonial center where ample evidence demonstrates an elite class who was buried with enormous quantities of exotic items and inferred sacrificial victims. In the case of both captives and elites, culturally sanctioned and highly ritualized public performances using various forms of violence were carried out to reinforce, perpetuate, and reproduce the ideology the organizational structures that created the divisions between the highest and lowest individuals in regional systems of social hierarchy.

Chaco Canyon

More volumes have been written about Chaco Canyon than any other site in North America. Why this is so is perhaps best captured by the following quote:

> Chaco was big. It was showy. It was expensive. It had clearly differentiated housing: "Great Houses" with high-status buildings on one side of the canyon, and small, modest, "unit pueblos" on the other. Not many people lived in the Great Houses, and several of those who did were buried with pomp, circumstance and, probably, retainers . . . Chaco was socially and politically "complex"—that is, a hierarchy, with definite haves and definite have-nots. Hierarchy, not heterarchy: A few people at Chaco regularly and customarily directed the actions of many other people. (Lekson 1999, 26)

Pueblo Bonito was the largest Great House in the Chaco Canyon complex. Nearly 700 rooms have been identified there. Room 33 is the most distinctive of these structures. Four characteristics distinguish Room 33 from the other burial rooms: the spatial distribution of the burials, the amount and type of grave goods, the high quality of health of the individuals, and the presence of violence-related injuries.

Two stratigraphic levels of burials were found in this room separated by a constructed floor. The upper level contained at least 12 sets of human remains and a number of grave goods, which for the most part, could not be associated with any single individual due to post-depositional periodic flooding associated with the upper floor. In contrast to the chaotic distribution of remains and grave goods on the upper level, the lower level contained two individuals in situ and grave goods directly associated with their remains (Fig. 14.1).

The distribution of graves goods is the second most prominent feature that sets Room 33 apart from other burials in Pueblo Bonito and all other sites in Chaco Canyon. In this room, there were thousands of grave goods that included ceramic vessels, baskets, lithics, worked or polished stones, ceremonial sticks, flutes, wrapped reeds, and numerous shell and turquoise beads and pendants. Though all of the individuals appear to have been interred with grave goods, the two remains found beneath the floor of the wood platform are associated with the majority of the material (Pepper 1909).

Figure 14.1. The two subfloor burials from Room 33 in Pueblo Bonito. Modified from Harrod (2013, 105, Figure 6).

The presence of thousands of turquoise grave goods found with these two burials in the log crypt suggests that they were prominent males from highly ranked clan lineages who served as elite members of the society, even perhaps as ceremonial leaders (e.g., priests). Mathien (2001) proposed an explanation for the great quantity of turquoise in Room 33. Turquoise played an important role for Pueblo Bonito and is found placed in Great Kivas, perhaps as an offering, beginning approximately AD 500, at sites such as 29SJ42. The importance of turquoise is not consistent, however; it peaked in the Basketmaker III and Pueblo II periods, the latter of which is associated with Room 33. According to Pepper (1909), the burials at Room 33 are unique. Analyses of burials in other Pueblos outside Chaco show little evidence that turquoise was use in grave goods. Peregrine (2001) suggested that turquoise consumption became so concentrated at Chaco because of the development of lineage-based corporate groups there.

Further support for clan- or lineage-based groups can be found in the distribution of particular grave goods. Mathien (2001) recounted Pepper's early twentieth-century proposition that the flutes found with the burials in Room 33 served a similar function as flutes associated with ritual ceremony (e.g., in the Flute Clan) that were associated with later Hopi and Zuni populations. Moreover, when excavating Room 38, Pepper (1909) recorded a large concentration of macaw remains beneath the floor, suggesting intentional interment as indicative of their ceremonial importance. Pepper (1909) offered further evidence that there was a Zuni clan known as Mulakwe, or Macaw, Clan. Thus, the macaw burials at Pueblo Bonito could signify either the origins of or an ancestral group to the Mulakwe Clan.

La Plata

Partial excavation of several communities situated along the confluence of the La Plata and the Animas Rivers in northern New Mexico was completed in 1993 as part of a highway construction project. The original analysis of these remains was undertaken in 1995 (see Martin et al. 2001 for a full accounting). Sixty-six individual burials dating to AD 900–1300 were preserved well enough to be analyzed for evidence of skeletal trauma. Mortuary contexts in the La Plata Valley revealed that most individuals were placed in the ground in a flexed position with grave goods (Martin and Akins 2001).

Analysis of individuals at the site of La Plata suggests that there was a subgroup of females with healed head wounds. This was unusual for this time period and cultural context. Other aspects of these females were distinctive; they were all mostly young to middle adult in age (approximately

Figure 14.2. Examples of entheseal changes on the postcranial bones of the females from La Plata. Modified from Martin et al. (2010, Figure 3).

20 to 40) and all of the women showed signs of hard physical labor (Fig. 14.2) (Martin 2008; Martin et al. 2008, 2010, 2013). Compared with age-matched males, the females demonstrated a much higher morbidity burden.

It is often suggested that particular shifts in settlement patterns are an indicator of warfare. For example, during the end of Pueblo III period, site location changed from open areas to hilltops and cliff dwellings such as Cliff Palace in the Mesa Verde region northwest of La Plata (Haas 1990). In considering the possible weapons that would be used in warfare, Wilcox and Hass (1994, 223–224) conducted a large survey of the material culture and found no archaeological evidence of weaponry. However, the problem is that weapons are difficult to differentiate from subsistence-related tools in the archeological record. For example, in a recent article, Reed and Geib (2013) discuss the role of the bow and arrow not as a hunting implement but as a weapon that facilitated the transition to greater sociopolitical complexity among the Pueblo people during the Basketmaker III period (AD 500–750).

Bioarchaeological Reflections of Hierarchy

Pueblo Bonito

There is ample evidence to inform the reconstruction of social complexity at Pueblo Bonito. The human remains recovered and partially analyzed over the years by various researchers fall into three general categories: the northern burial cluster, the western burial cluster, and other burials located in smaller sites in the canyon (Akins 2003). Room 33 is part of the northern burial cluster. This is an important distinction; Akins (2003, 100–101) identifies several biological characteristics for the northern burial cluster that distinguish them as having better overall health. The members of northern burial cluster are often cited as the individuals who are documented as having had higher social standing in the Chacoan world. The burial context of these inferred elites is unique for both this site and the region as a whole because of the exotic items placed in the room (Pepper 1909, 1920). Evidence for the concept of lineages in Pueblo Bonito is supported by both intra-population craniometric comparisons of Chaco Canyon skeletal remains, which are further supported by reference to modern Pueblo populations (Mathien 2001), and the distribution of artifacts throughout the Great House. Akins (1986), who compared burials from different sections

of Pueblo Bonito, found evidence of the presence of two distinct groups. Akins's findings gain support from an even more sophisticated biodistance comparison of cranial variation from Pueblo Bonito to crania from other Pueblo sites. Schillaci and colleagues (Schillaci et al. 2001; Schillaci and Stojanowski 2003) found that individuals from different areas of the Great House could be assigned to one of two known population groups: the Hopi and Zuni or the Pueblos in the Rio Grande Valley.

Examinations of terminal adult stature as a cumulative measure of biological stress in ancient populations, such as that found in Cohen (1984, 5), Cohen and Crane-Kramer (2007b, 336), and Goodman and Martin (2002, 21–22), have documented a strong association between adult stature, nutritional status, and access to sufficient resources. These findings are concordant with documented variation of growth and development patterns recorded among non-Western populations around the world (Bogin 1988, 2001; Little and Gray 1990). Even economists use adult stature in living populations as a measure of socioeconomic status (e.g., Boix and Rosenbluth this volume), and there is ample data to support the proposition that taller terminal adult stature is positively correlated with wealth (Steckel 1995, 1903). Because stature is linked to both general health and status, it is one of the more powerful measures that is used to document general poor health and lower social status, particularly if disruption occurs during the critical period of growth between birth and two years of age (Floyd and Littleton 2006).

According to Akins (2003, 100) and Stodder (1989), the stature estimates (based on maximum femur length) for males and females from the northern cluster are among the tallest for skeletal series in the Southwest. Stodder reports that the mean femoral length for males in the northern cluster was 44.5 cm and that the mean for females was 41.6 cm. The average for males in the western cluster was 43.6 cm; for females, it was 41.3 cm. Akins (2003, 100) reports that the averages for small site Chaco Canyon dwellers is 42.8 cm for males and 39.1 cm for females. Martin and colleagues (1991, 93) showed that at Black Mesa, Arizona (AD 900–1150), the average femur length is 42.9 cm for males and 40.7 cm for females. Data on femoral length from the La Plata region in New Mexico (ca. AD 1000) is 42.1 cm for males and 39.6 cm for females (Martin et al. 2001, 99). Thus, there is strong evidence from a number of samples that the people buried in Room 33 at Chaco Canyon were likely particularly well nourished.

Other health indicators are consistent with this observation. Palkovich (1984, 430–431) examined health indicators for the elites at Pueblo Bonito.

Her original hypothesis stated that higher-status people would be buffered from general environmental and nutritional constraints. She showed that the 95 individuals from the four Pueblo Bonito burial rooms in the northern cluster did not reflect a normal age distribution, as infants and children were underrepresented. She also found that females outnumbered males by a ratio of two to one (42 versus 22 individuals). Akins and Schelberg (1984) presented craniometric data that suggest the presence of two social lineages among these burials. The combined data sets (burial context, grave goods, craniometrics, health indicators, stature) led Palkovich (1984, 431–432) to state that the individuals in these burial rooms "represented high-ranking lineages in a stratified Chacoan society." In a reanalysis of all of the existing burial data for the northern cluster, Akins (2003, 100) found that "in addition to greater stature, the rate for porotic hyperostosis . . . is among the lowest reported for southwestern populations and far lower than the figure for the Chacoan small-site population." She found that porotic hyperostosis was present among 83 percent of subadults from small sites but that only 25 percent of subadults from Pueblo Bonito were similarly afflicted. The mean age-at-death profiles Akins constructed demonstrate that the elites at Pueblo Bonito enjoyed longer life spans than contemporaries in other locations.

Nelson and colleagues (1994) compared demographic and health-related variables among five regionally distinctive skeletal populations of the Southwest, comparing Chaco Canyon with Black Mesa, Arroyo Hondo, Casas Grandes, and Mesa Verde. Their conclusions indicate that the elites at Pueblo Bonito had better overall health based on older ages at death, lower rates of childhood anemia (17 percent), and lower rates of trauma (17 percent) (Nelson et al. 1994, 97). Interestingly, Pueblo Bonito elites do show comparable rates of enamel defects with other Southwest groups (approximately one per individual). Thus, it appears that during childhood, even high-status individuals were not able to avoid episodic growth disruptions from stressors such as weaning, childhood illness, or resource deprivation.

However, the individuals of greatest relevance to our understanding of hierarchy and violence are the two tall males buried in log crypts at Pueblo Bonito. As Lekson (1999, 26) informally exclaimed, "If ever anyone in the Pueblo Southwest were elite, it was those two guys buried in the famous log crypts." The argument for higher social status of these burials, especially the two in the lower floors, is supported by bone chemistry. Analysis of variation in nitrogen stable isotopes suggests that these burials were unique among Pueblo II people. Burial H/3671 had a $\delta^{15}N$ value of +11.4‰, while

the $\delta^{15}N$ value of Burial H/3672 was even heavier at +12.4‰. The importance of these values is that they reflect much higher $\delta^{15}N$ levels than both Basketmaker and earlier Pueblo period burials, which averaged between +5.7‰ and +8.6‰ (Coltrain et al. 2007, 317). These data suggest that these individuals may have had access to better or more sources of protein. Along with the analysis of the isotopic signatures, Coltrain and colleagues determined from radiocarbon dates that the burials date to around the beginning of construction at Pueblo Bonito (AD 690–944); this was confirmed by more recent research by Plog and Heitman (2010). The importance of this date is that it implies that these individuals were high-status males who were adorned with elaborate graves goods before Chaco reached the height of its social and spatial complexity.

Recent reanalysis of the burials at Pueblo Bonito by Harrod (2012, 2013) and the authors of this chapter lend support to the view that these males may have been high-status individuals. The research compared individuals from Room 33 to other individuals in other rooms of Pueblo Bonito and to individuals from additional archaeological sites in the region (N = 271). The results suggest that both the males and females interred in Room 33 may have been prominent members of the Ancestral Pueblo community in Chaco Canyon based on assessment of skeletal markers of nutrition, activity, health, and trauma (Harrod 2013). However, elevated status did not completely buffer these individuals. Several had experienced nonlethal trauma, including one female, and two males (and possibly a third) had suffered perimortem cranial fractures that most likely contributed to their deaths. The question is why they experienced such violence. It could be that individuals in Room 33 with perimortem trauma had violated some social norms and were executed as a result. The problem with this explanation is that it is unlikely that a person viewed as a social deviant would be interred with such a large amount of elaborate grave goods; a functional-symbolic interpretation suggests that this individual was either a warrior or a venerated elite. Baadsgaard and colleagues' (2011) analysis of high-ranking burials from Ur in Mesopotamia found that high-status individuals were ritually killed by blows to the back of the head as a way to venerate social elites. These individuals were also interred with a high number of exotic grave goods. Although it appears that the two males recovered from Room 33 were high-status males, the question that remains is whether they were warriors, chiefs, or leaders (see Akins 2003 for complete discussion).

La Plata

In the north, there is also evidence of social differentiation among the burials. Females without head wounds and all males were located in structures in the typical fashion; that is, with grave goods and in a flexed position. In contrast, the females whose skeletons showed trauma and signs of activity-related stress markers were found in very different mortuary contexts. They were found in random positions suggestive of having been thrown into pit structures from a higher elevation. There were no grave goods with any of these remains.

Violence against this group of women can be best understood in the broader context of social processes (Martin et al. 2001, 92–95). A number of cultural mechanisms associated with gender and status seem to have differentially affected a segment of the community made up of women of reproductive age (Fig. 14.3). In addition, because many injuries had healed, the women who survived them became, in effect, social targets: the high

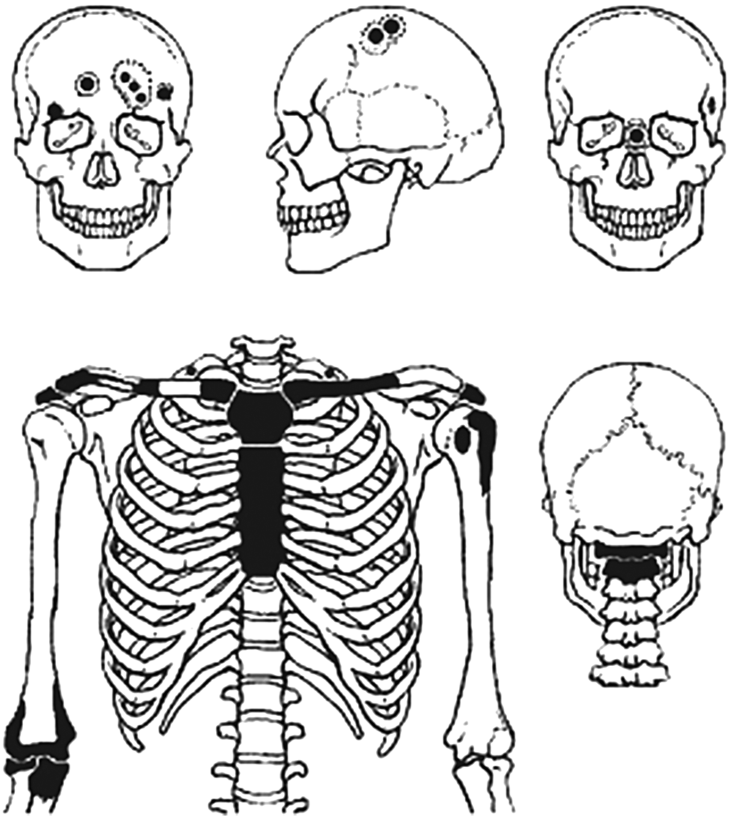

Figure 14.3. Illustration of trauma and associated postcranial osteomyelitis on LA 37601 Burial 4. Modified from Martin et al. (2001, Figure 4.26). Courtesy of Robert Turner, Office of Archaeological Studies, Department of Cultural Affairs, Santa Fe, NM.

rate of injury recidivism among these women led Martin and colleagues to argue that they would have suffered the added burdens of poor health and the behavioral changes associated with being physically abused (see Martin 2008; Martin et al. 2001, 2010 for discussion).

Of the 13 adult males that could be analyzed at La Plata, three showed evidence of slight cranial depression fractures and three had postcranial trauma: one to a rib, another to a finger, and another to a wrist bone. Of the 12 adult females, six had severe cranial depression fractures that had healed. Several of these females showed postcranial trauma and abnormalities as well. Of the 16 infants and children, one individual exhibited a very shallow healed cranial depression fracture (Martin et al. 2001, 103).

Discussion and Conclusions

The goal of each chapter in this volume is to explore evidence of a connection between aspects of skeletal biology and social complexity, whatever that evidence may be. In this chapter, we focused on evidence of how a hierarchical socioeconomic structure can be revealed by patterns of trauma and differential health at two sites in the Southwest. The two skeletal samples of human remains indicate that there were varying degrees of social stratification or hierarchy in the region. The analysis of violence-related trauma on the skeleton is a useful way of ascertaining hierarchy, as there tend to be patterns involving who is or is not affected and the location and severity of trauma. Each of these factors is contingent on social status. When evaluating either direct (e.g., lethal and nonlethal trauma) or structural (e.g., skeletal pathology, entheses, and variations in burial pattern as a sign of access to socioeconomic capital) expressions of violence, the segment of the population most vulnerable to repeated trauma and poor health are often low ranking (e.g., Klaus 2012).

The skeletal and archaeological evidence lends credibility to the view that the individuals buried in Room 33 may have been prominent members in their society, conceivably elites and ceremonial leaders, whose lives had great importance in the Chacoan world view. In contrast, the burials at La Plata seem to have been low-status individuals who were exploited for labor. Regardless of the specific role these individuals played, the very nature of their burials is highly suggestive that they represent a kind of a snapshot of people's lives at either ends of the spectrum of a complex social hierarchy among the Ancestral Pueblo in the pre-contact U.S. Southwest. The interpretation that Pueblo Bonito served as a ceremonial center for a

number of lineages that inhabited various sites throughout is quite plausible (Lekson 1999; Peregrine 2001; Schillaci 2003). It is possible that being buried in Pueblo Bonito was a great honor bestowed upon relatively few Ancestral Puebloan people in the San Juan Basin.

Haas and Creamer (1993) have suggested that the patterns of "chronic warfare" and level of violence seen in the Ancestral Pueblo world from the twelfth to the fourteenth centuries indicate that previously more egalitarian and loosely connected groups had formed larger stratified and politically centralized units in the period AD 1100–1300. When viewed collectively, the archaeological data on fortification, strategic location, and the data from the human skeletal remains of the victims of violence and dismembered bodies indicate that fighting often appeared in many different forms in the region (e.g., ambushes, raids, skirmishes, witch executions, and attacks by groups of aggressors).

Lekson and colleagues (1988) argued that an additional mechanism that drove communal aggregation and the development of hierarchy may have been climatic variability that resulted in fluctuations in resource predictability and gave rise to important ceremonial centers involved in storage and redistribution. Within these ceremonial centers, hierarchies may have developed in order to manage these collective resources.

In his 2002 article, Lekson argues that whether data illustrating trauma and violent death in the archaeological record is taken as evidence of independent events or as evidence of anomalous occurrences, such events have no well-defined sociocultural implications. However, when such evidence is woven into regional data that demonstrate a similar pattern of violent events, migrations, and site abandonment and culminate in movements of people south and east, the significance of these events in relation to the role of hierarchy becomes more evident.

Moreover, the inequalities that can arise in a hierarchical system often affect access to nutritious foods and other goods that impact quality of life. The effects of such are felt most directly by those with limited social power, as they would have been vulnerable to inadequate nutrition and the associated health effects, extreme workloads, and possible recurrent acts of violence. When this social reality is contrasted with that reflected in the elite burials from Chaco, a picture of differential health, life, and death begins to emerge. The nuanced use of bioarchaeological data framed within their cultural contexts can thus provide a measure of the impact that social differences had on human populations and the subgroups that constitute them.

In conclusion, the anthropological study of hierarchy helps us realize a broader understanding of the larger historical processes that lead to the development and maintenance of social power. One of the central features of hierarchies is the culturally sanctioned use of violence to reinforce the position of elites or those with power. The bioarchaeological record in the U.S. Southwest provides the opportunity to study hierarchy, health, and violence in a particular place and time, but the contexts they reveal have far-reaching implications for our understanding of violence through time and around the world.

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15

Hierarchy and Urbanism in Pre-Columbian Central Mexico

An Initial Assessment of Biological Stress and Social Structure at Teotihuacan and Monte Alban

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The central highlands of Mexico were home to many complex societies during the pre-Columbian era. Mesoamerica, which included most of Mexico and northern Central America, is considered to have independently developed "civilization" and urbanism. Settlements with social differentiation developed in central Mexico a few centuries before the Common Era, and the earliest true cities seem to have developed by the first century CE. Two of the most important were Teotihuacan in the Valley of Mexico and Monte Alban in the Valley of Oaxaca. Both sites have yielded skeletal samples of their inhabitants. Thus, this region allows bioarchaeologists to study the effects of population density and status differences on the health and well-being of individuals through their skeletons. Previous work in historical and skeletal populations has indicated that increased population density incurred a cost in morbidity and mortality (e.g., Wrigley et al. 1967; Steckel and Rose 2002). Research on historical and contemporary populations also demonstrates that the poor are impacted by heightened morbidity and mortality (Goodman 1998; Goodman et al. 1992). Thus, it is expected that the preindustrial cities of central Mexico will also reveal the effects of density and socioeconomic status. The pre-Columbian New World lacked the crowd-type epidemic diseases of the Old World and had mostly endemic infectious diseases (Merbs 1992). Thus, the patterns of morbidity and mortality may be quite different. However, it is expected that those of

high social status will be buffered to a greater extent against the biological stresses that appear on bones than individuals of low social status.

In this chapter, we compare the stress indicators in Teotihuacan and Monte Alban skeletons by early and late chronological periods and by status. The chronological periods are determined by the archaeological dating of associated artifacts, but determining status differences can be more challenging. There are actually two social dimensions to consider in determining status in the context of an urban complex society.

First, there were variations in neighborhoods. Some neighborhoods were more prestigious and were closer to important public and ceremonial buildings. Variety in size and in the construction materials of residences indicated wealth and power hierarchies in pre-Columbian cities, although the residences in some neighborhoods in Teotihuacan indicated mixed wealth. Many apartment compounds in Teotihuacan may have had similar outer walls, but the plans inside were variable, tailored to the needs and reflecting the wealth of residents. Thus, compound plans varied from spacious rooms with murals to more cramped quarters. Excavated compounds can be ranked in status by the quality of construction and the spaciousness of its interiors. Also important was a residence's proximity to neighborhood administrative and ritual centers (Manzanilla 2012). Second, there was variation in status within a residence, often driven by differences in achieved positions that are influenced by age, sex, and personal abilities. These variations perhaps had importance only in the residences, where the highest statuses may have been reserved for the leaders who represented a residence at the neighborhood level. These may be considered as heterarchical differences.

Two types of archaeological evidence can be used to study status differences. One set of important markers involves the variable locations of interments within a residence (the pre-Columbian Mesoamerican pattern involves burial within and around residences). The other is the mortuary treatment of an individual, including grave type and grave offerings. Such treatment is often an indicator of the importance of the deceased person and that of the mourners, although some exceptions are not strictly determined by the social status of the deceased (Chesson 2001; Rakita et al. 2005). In the samples examined here, location and mortuary treatment do show status differences. While more than two status ranks might be present, the small sample sizes are divided into just two ranks for the purposes of statistical testing.

In this work, it is possible to test two models of social status and health in urban central Mexico. First, if higher status involved the existence of a more buffered urban environment in pre-Hispanic central Mexico, then it can be hypothesized that individuals interred in the higher-status residences had a generally lower prevalence of paleopathological indicators of morbidity compared to people interred in lower-status settings. But what if little to no paleopathological variation existed between high and low status in residences? A second model entertains the possibility that status may have been largely achieved in adulthood through individual initiative and talent. In the first model, we expect residences with higher status to show less morbidity because the environment and the resources that were available to such residences were better throughout life. In the second model, there will be no differences between the internal statuses of a residence, likely owing to the fact that environment and available resources were largely similar for all residents.

Materials and Methods

Teotihuacan and the Tlajinga and La Ventilla Neighborhoods

Teotihuacan was the earliest city (150 BCE to circa 650 CE) in Mesoamerica and one of the largest in the world at its peak. It grew rapidly, attaining its maximum population around 300 CE, when a clear city plan with neighborhoods and apartment compounds appeared. The apartment compounds were large structures housing multiple families, many probably large kin groups (Manzanilla 1996). The compounds have obvious apartments, open activity areas, and a shared principal patio that was the focus of compound-wide ritual, especially those related to ancestor veneration (Manzanilla 1996; Headrick 2007). While co-residing corporate kin groups were characteristic of pre-Hispanic central Mexico (Carballo 2012), some compounds were probably multiethnic, housing immigrants with particular craft specializations and important clients from elsewhere in Mesoamerica (Manzanilla 2012). Near the ceremonial center of the city, the apartment compounds each formed a block with thick outer walls separated by streets. In peripheral areas, the population was more dispersed and the layout of compounds was more variable. The neighborhoods consisted of clusters of compounds that were often linked by craft specializations. The La Ventilla and Tlajinga 33 skeletal samples represent different neighborhoods.

Tlajinga 33

The Tlajinga neighborhood is in the southern part of the city, similar to a suburb. The compounds in Tlajinga were dispersed and were the focus of ceramic production during the later phases of the city's occupation (Cowgill 1997). Tlajinga appears to have been a craft production community that was probably organized at the neighborhood level. Multiple family members likely did Teotihuacan crafting, and it is likely that multi-craft production occurred in many compounds (Manzanilla 2009).

Founded during the Early Tlamimilolpa period (probably CE 250–300), Tlajinga 33 was a modest compound located just west of the central Avenue of the Dead. The specialized production of San Martin Orange wares was done during the later Xolalpan phases of occupation, so an important question excavators sought to answer was what the residents did during earlier occupations. For the first 100–150 years of the compound's existence, the residents specialized in lapidary work, using both exotic and common materials such as shell, greenstone, slate, and travertine (Widmer 1991).

The Tlajinga 33 compound was erected from modest building materials, such as adobe for walls, cobblestones for one of the main courtyards, and earth for floors (see Fig. 15.1). However, by Xolalpan times, the compound had stuccoed walls and plastered floors, but most of the walls consisted of

Figure 15.1. View of Tlajinga 33 excavation with cobblestone and adobe walls visible. The plan of rooms and patios appears haphazard. The compound is also smaller than the compound at La Ventilla. Photo courtesy of Randolph Widmer.

only a few stone courses at the base and adobe for the rest of the structure. The compound was abandoned in the Early Metepec (ca. CE 550).

Most individuals buried in the Tlajinga 33 compound were accompanied by no offerings or just one or two items. They were interred in earthen pits, often in the apartment floors. A few individuals had up to 42 items and were buried in pits partially dug into the underlying bedrock. The locations of these wealthier graves varied; some were located under altars in the main courtyard, others under activity areas, and others in apartment floors. The latter individuals are considered to have high status in the compound, while the individuals in earthen pits with few grave offerings were members of the lower-status group. From its peripheral location, modest building materials, irregular layout, and generally modest burial offerings, Tlajinga 33 appears to have been a residence of lower-status artisans in the city.

La Ventilla

The neighborhood at La Ventilla is close to the center of Teotihuacan, just west of the central axis of the city, and was characterized by stuccoed and plastered walls and floors, boundary walls, and streets more typical of apartment compounds that were more densely packed than the ones in Tlajinga 33. The skeletal sample here was excavated in 1992 and 1994. The social status of the residents of the compound was determined from construction materials, types of buildings present, size of the space, and funerary offerings (Gómez and Hernandez 1999). Like the buildings in Tlajinga 33, they date from the Early Tlamimilolpa to Metepec periods (Gómez and Hernandez 1999).

The skeletons at La Ventilla are from different apartment compounds that had different functions in the neighborhood. One was a very well-built compound with temples and murals in rooms and an adjoining residence. It is inferred that these residential areas were for elites, perhaps people charged with neighborhood ritual and administration, although there were also a few interments in the temple compound. All individuals here are considered to have been of high status. The surrounding compounds contained a few interments with no or one grave offering and are considered to have ranked as low status. Another compound a short distance away provided the bulk of the individuals in the sample (Huichochea and Márquez Morfín 2006). Some were from exclusively domestic contexts, while others were located in the area of the compound where the residents were skilled lapidaries in stone, shell, and bone (wealth-related materials).

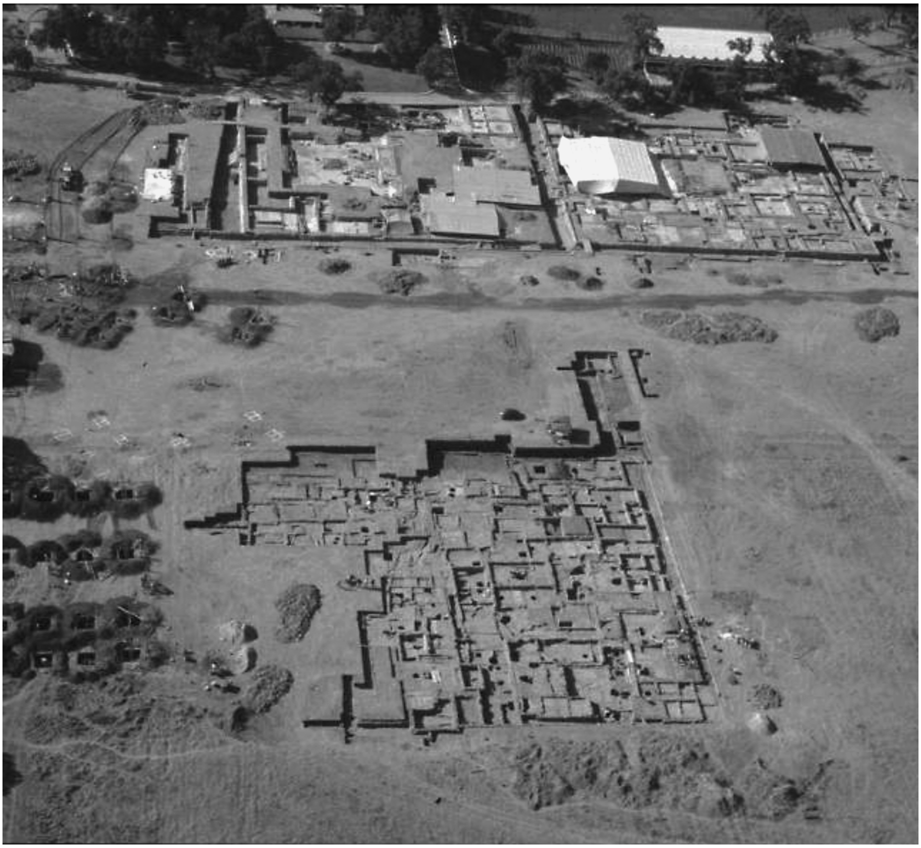

Figure 15.2. Aerial photo of the La Ventilla excavations, 1992–1994. Templo/Glifos is at the top and the Artisans/Domestic Compound is at the bottom. Note the more orderly plan and clear boundary walls at top. Photo courtesy of Lourdes Márquez Morfín and INAH, Mexico.

Because of this, the Mexican archaeologists designated this the Artisans/Domestics compound. These individuals were co-residents of a single compound, where they lived with many likely related kin, so they are treated as one sample. The construction of this compound and the burial offerings were modest. For this work, Storey assigned status in this compound for comparison with Tlajinga 33, based on both the location of the interment and the number of grave offerings as provided by co-author, Fernandez N. Individuals interred under or near altars in courtyards and those with five or more grave offerings were coded as high status. All others were coded as lower status. The compounds at La Ventilla appear to have been of a higher status than the compound at Tlajinga 33 based on their more central location, stone construction, stuccoed walls, and ample plazas (see Fig 15.2).

Another indicator of the high status of La Ventilla is that it had a formal compound for each neighborhood function, including a temple, an administrative building/residence, and compounds for common people (Manzanilla 2009). In fact, because of its very central location and its expansive administrative/ritual compound, La Ventilla may actually have been the center of its quadrant of the city (Manzanilla 2012).

Monte Alban

Monte Alban, located in the center of the Valley of Oaxaca, was another early urban locus in central Mexico. This city was founded slightly earlier than Teotihuacan, but because Teotihuacan grew and expanded quickly, Monte Alban reached its height in population and public construction slightly later. These skeletal samples temporally overlap with those from Teotihuacan (most are 100/150 BCE–500 CE, or Monte Alban II and IIIa). From its beginning, Monte Alban was the center of power in the Valley of Oaxaca; it was founded on a hill where the three arms of the valley intersected. Most of the residential units were built on artificially leveled terraces on the slopes of the hill, where a population of 25,000 to 30,000 lived during the apex of the site. As at Teotihuacan, these were multifamily residences. A yet-to-be-determined percentage of the total of Monte Alban residences belonged to a sort of intermediate elite or were people of middle-range status.

The residents of the four houses from which the skeletal samples were documented are considered to have been at an intermediate social status, from neither the highest elite nor the lowest status at Monte Alban (González 2009). These residents are inferred, in essence, to have been wealthy commoners and the minor elite from two neighborhoods, Plumaje and the Central Area. As in Teotihuacan, there were definite status differences in the residence. The mortuary pattern was that each household constructed a tomb in which various individuals who had attained status in the residence were buried. These individuals were considered to have had high status and actually had almost all the most valuable objects of jade, shell, and polychrome ceramics as grave goods. Others were buried under rooms and patios and are considered to have been of lower status (Márquez and González 2001).

The Skeletal Samples

A total of 206 skeletal individuals were recovered from the Tlajinga excavation, but most were represented by only a few skeletal elements. Only

63 individuals in primary and secondary interments could be associated with a particular social status. The rest were recovered from middens and were probably disturbed interments whose original mortuary treatment is unknown. The numbers available for each age that can be scored for health indicators is thus a small percentage of the entire sample. The sample is divided into Early (Tlamimilolpa Phase) and Late (Xolalpan/Metepec Phase) phases, reflecting the lapidary specialization of the Early phase and the addition of ceramic production in the Late phase.

In La Ventilla, the sample of 138 individuals was comprised of 32 individuals from the temple/residence compounds, 71 inferred artisans, and 35 domestic area individuals from the second compound. Again, skeletal preservation affected the number of individuals who could be scored for health indicators. The temple/residence compounds are of the same date as the Tlajinga 33 compound and were divided into similar Early and Late phases. The Artisans/Domestics compound dates from a little later, so its Early phase is equivalent to Late Tlamimilolpa/Early Xolalpan and its Late phase corresponds to the Late Xolalpan/Metepec in Tlajinga 33. This is not quite the same chronology, but it is fairly close.

The Monte Alban sample was composed of 151 individuals, 51 of whom were documented in tombs and 100 of whom were buried under patios and rooms in the four residences. These are mostly equivalent to the Early phase at Teotihuacan and thus are analyzed only by high versus low status to facilitate comparison to the sample at Teotihuacan. Again, the number of individuals that can be scored for the different indicators is small.

Indicators of Biological Stress

We chose to use four paleopathological indicators to compare the diverse samples because they are commonly found in skeletal samples (for further descriptions, see Buikstra and Ubelaker 1994). Porotic hyperostosis, a lesion of the outer cranial vault, results from an anemic condition during childhood. The spongy porosity of the lesion heals but can still be scored in adults, usually as an uneven surface with remnant porosity. It was scored as present or absent if the parietal and the frontal squama of the cranium were present. Enamel hypoplasias on permanent canines and incisors are linear depressions or pits indicating disturbance of enamel thickness during tooth development. This disturbance can be caused by many possible forms of physiological stresses, so the indicator is nonspecific. Since enamel does not remodel, these remain visible throughout life and can be scored in adults. These were scored as present when a dental probe registered a line

or pit of diminished enamel thickness on only the permanent incisors and canines, which are the most susceptible teeth.

Periosteal reactions are raised areas of pathological new bone on the cortical surface of skeletal elements. Tibial periosteal reactions (the bone most commonly affected) and periosteal reactions on the rest of the skeleton often result from bacterial infections or other types of inflammatory processes that can occur by themselves or as a secondary complication of other diseases. Tibias were scored if either diaphysis was at least half complete, and at least two different skeletal elements had to show reactions to be scored as present for a more systemic nonspecific periosteal reaction. These were scored as present if a clearly raised area was identified on the cortical surface and was not associated with new bone growth in subadults. These lesions indicate hygienic problems of the environment and the ability of an individual to survive the infection for at least a time or until healed. Additionally, no clear evidence of rickets or scurvy was observed in the samples. Porotic hyperostosis and enamel hypoplasias are the result of stresses during childhood, while periosteal reactions can happen at any age. In this respect, all ages of the lifespan are vulnerable to paleopathological phenomenon.

All paleopathological indicators were scored as present or absent in individual skeletons and not by severity or whether the lesions were active or healed. This was done to allow the comparisons among the groups to be made using the odds ratio, a preferred measure when comparing prevalence between assemblages in paleoepidemiology (Waldron 2007; Klaus 2014; Klaus, Shimada et al. this volume). The interpretation of the odds ratio, which can be calculated on a 2 × 2 contingency table, is fairly straightforward. If prevalence is the same between two groups, the odds ratio will equal 1.0. If the odds ratio is greater than 1.0, then prevalence is greater in the first of two samples being compared; if the odds ratio is less than 1.0, then the second sample has the greater prevalence. A 95 percent confidence interval indicates whether the odds ratio is statistically significant. If this interval contains 1.0, the odds ratio is not significant. A confidence interval above or below 1.0 indicates significance. All statistical operations were calculated in SPSS 22.

Results

Individuals assigned to high and low social status were compared for all of the Teotihuacan compounds combined, then each compound was in-

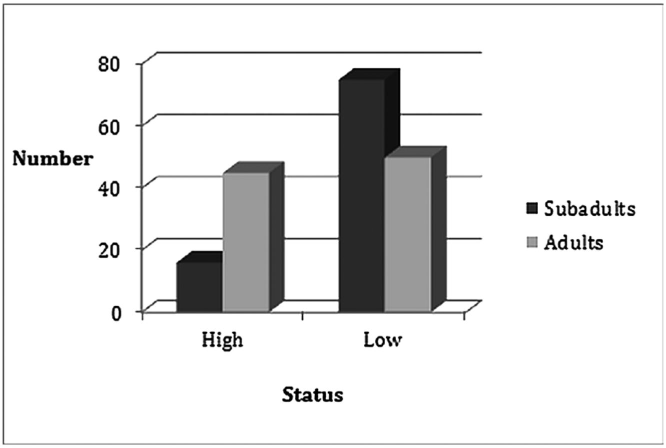

Figure 15.3. Age and status at Teotihuacan.

vestigated separately. A total of 186 individuals could be assigned a social status. Figure 15.3 compares subadults (under age 15) to adults. There were definitely fewer subadults than adults in the high-status grouping ($\chi^2 = 18.7$, $df = 1$, $p = 0.0001$), whereas the adults are about evenly divided between the two statuses. Sex estimation was possible on only 66 individuals. Fourteen high-status females and 1 low-status female were identified. Twenty-one high-status and 17 low-status males were identified. While there is a slightly greater number of higher-status males, this difference is not statistically significant ($\chi^2 = 0.179$, $df = 1$, $p = 0.672$).

Using the odds ratio (OR) as the probability of being afflicted by a particular condition, the status designations for all compounds combined were compared against the health indicators. The presence or absence of porotic hyperostosis, enamel hypoplasias, and periosteal reactions on tibia or other parts of the skeleton were all nonsignificant, meaning that neither high nor low status corresponded to patterns of morbidity. The same result was found for sex, as males and females were equally likely to be affected by these pathological conditions. When these indicators were tested against age and chronology, significant differences emerged. Figure 15.4 shows the results for porotic hyperostosis and hypoplasias by age. Adults are the first sample and subadults the second. The odds ratio results for porotic hyperostosis was 16.0 (95 percent CI = 3.6–71.4), meaning that subadults rarely had the lesion, while adults had almost all the lesions. The same pattern is seen for enamel hypoplasias: OR = 3.4 (95 percent CI = 1.5–7.6) and adults were more than three times more likely to have the pathological condition than subadults. Periosteal reactions on the tibia and the skeleton were

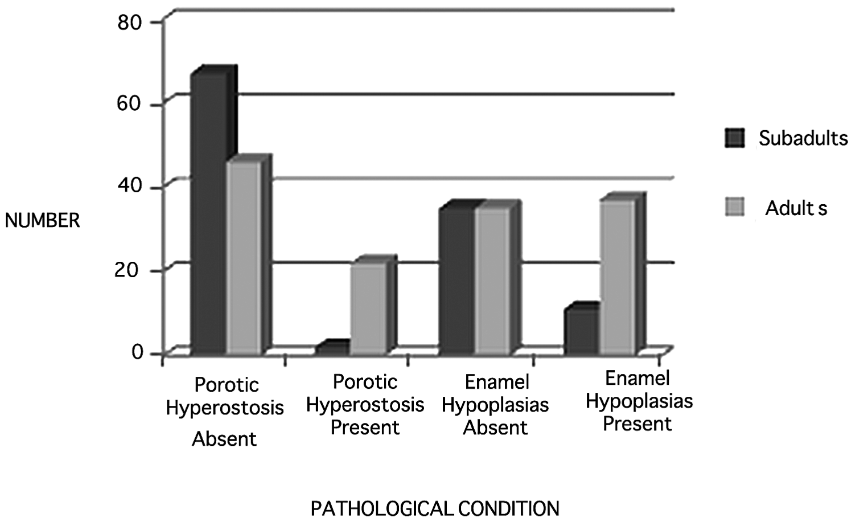

Figure 15.4. Porotic hyperostosis and enamel hypoplasia distributions at Teotihuacan.

nonsignificant, indicating that both ages were equally likely to have the condition.

Fig. 15.5, which compares stress indicators in the Early and Late temporal samples, shows that the pattern for enamel hypoplasias and skeletal infection had significant odds ratio results, while variation in the presence of porotic hyperostosis and tibial periostosis was not significant. The Early Phase individuals are sample 1; the Late Phase is sample 2. For enamel hypoplasias, the OR = 3.6 (95 percent CI = 1.6–8.0) and for generalized nonspecified skeletal periostosis, OR = 3.3 (95 percent CI = 1.6–6.6). Thus, Early Phase individuals were three times more likely to have hypoplasias and generalized skeletal infections than Late Phase individuals. In this case, both phases also had equal chances of no porotic hyperostosis or tibial periosteal reactions.

Knowing that age affects status at death and that both age and chronology comparisons demonstrate significant odds ratio values with some pathological conditions, the next step was to control for status to test if there were differences in the prevalence of the indicators. When comparisons were made by sex controlling for status (i.e., comparisons between all high-status males and females and then between all low-status males and females), no significant differences were found in any of the comparisons. The small subsamples (high status = 27 and low status = 21) probably did not provide enough power in these cases to demonstrate significance.

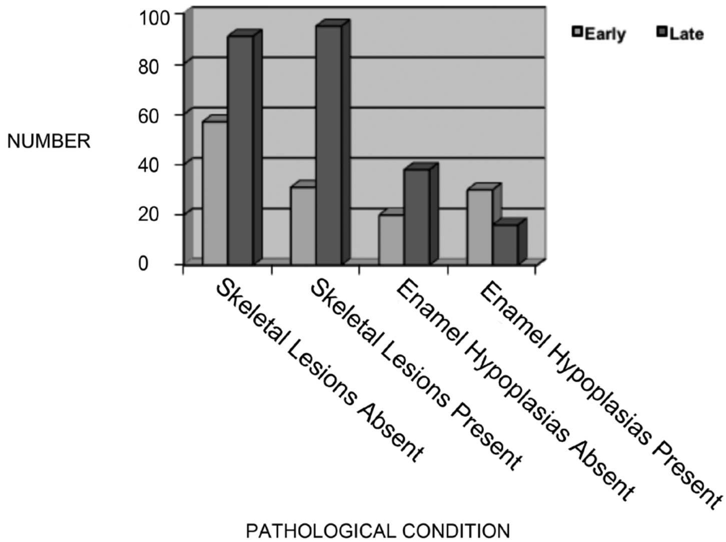

Figure 15.5. Presence and absence of skeletal lesions and enamel hypoplasias at Teotihuacan.

Porotic Hyperostosis

This indicator showed a significant relationship with age, as adults were more likely to have the lesion. When only high-status individuals are compared for the presence or absence of this lesion by age, no odds ratio can be calculated, because no high-status subadult had related lesions (n = 11), although 10 of 31 (32 percent) high-status adults did. For the low-status sample, the odds ratio is significant; adults were 15.6 times more likely to show the lesion (CI = 3.1–77.1). Only 2 of 53 subadults and 11 of 29 (38 percent) adults were affected by anemia. When one compares age distribution by the presence or absence of this indicator in both high and low status, the Mantel-Haenszel estimate for the common odds ratio was also significant (OR = 21.5, CI = 4.1–112.6) for the 124 total individuals in this comparison, indicating that the difference between statuses is significant. Although the extremely large CIs for this paleopathological indicator indicate that the actual odds ratio estimate is uncertain, it is strong in the structure of the pattern.

Enamel Hypoplasias

This indicator varied significantly by age and chronology, as adults and Early Phase individuals were more likely to be affected. Again, when com-

paring only within a status group, the odds ratio for high-status individuals is nonsignificant, so age does not relate to the presence of this lesion. However, for low-status individuals, the odds ratio is significant; OR = 7.0 (95 percent CI = 2.0–24.3), indicating that adults are seven times more likely to have this lesion than subadults. Only 4 subadults of 32 (12.5 percent) had enamel defects, compared to 17 of 34 adults affected (50 percent). Yet the Mantel-Haenszel common odds estimate for presence or absence by age and both high and low status was significant at 4.5 (95 percent CI = 1.8–11.4) for 103 individuals. In high-status individuals, 4 of 11 (36 percent) subadults and 15 of 26 (58 percent) adults had the lesion, so a greater proportion of these individuals had to survive whatever stressors led to disrupted enamel formation, as was the case for the low-status adults.

Periosteal Reactions

Variation in this indicator was not significant in the previous comparisons. Prevalence differences among high-status individuals were not significant, and subadults and adults were equally likely to display a lesion. However, the odds ratio for the low-status individuals was significant: OR = 3.7 (95 percent, CI = 1.2–11.3), indicating that adults were more likely to have a lesion than subadults. Only 6 of 47 (13 percent) subadults had a lesion, while 12 of 34 (35 percent) adults were affected. Here the Mantel-Haenszel common odds estimate between high and low status groups was not significant for this indicator.

Nonspecific Skeletal Periosteal Reactions

This indicator was significant in the overall comparison of chronology; the Early Phase individuals had a higher prevalence of these lesions. Comparisons by status showed that in both the high-status and the low-status groups, subadults and adults were just as likely to be affected by these skeletal lesions.

The next step was to compare hypoplastic defects between the compounds. Overall, Templo/Glifos was characterized by the highest social status, followed by the craft specialists in the Artisans/Domestics compound, and then by Tlajinga 33. When we compared prevalence by age in each compound, only adults demonstrated lesions in La Ventilla, while at Tlajinga 33 the odds ratio value indicates that both age groups are equally likely to be affected by enamel hypoplasias. Hypoplasias were restricted to adults in both of the residential samples at La Ventilla. In Tlajinga 33, the odds ratio comparisons were not significant, as both subadults and adults

Table 15.1. Pattern of skeletal stress indicators in the Artisans/Domestics and Tlajinga 33 compounds

Compound	Porotic hyperostosis	Enamel hypoplasias	Nonspecific periosteal reactions
Artisans/domestics compound			
High status	Only adults were affected	Only adults were affected	Only adults have tibial or other skeletal lesions
Low status	Only adults were affected	Only adults were affected	Only adults have tibial or other skeletal lesions
Tlajinga 33			
High status	Only adults were affected	All individuals were affected	Not significant; an equal prevalence of tibial involvement across ages but a significant difference for other skeletal lesions (adults had greater prevalence)
Low status	Only subadults had lesions	Significant difference; only three subadults were unaffected	Significant difference; only one subadult had no tibial lesion. No significant difference across age groups for other skeletal lesions.

were equally affected. Porotic hyperostosis showed the same pattern. Both samples at La Ventilla samples had no subadults with tibial reactions. No adults at Templo/Glifos were affected by nonspecific skeletal reactions, and no subadults in the Artisans/Domestics compound were affected by such lesions. Only Tlajinga 33 showed a variation in the internal odds ratio, but it was not significant for either type of periosteal reactions. For example, skeletal reactions had an OR = 0.50 (95 percent CI = 0.21 to 1.2). Basically, odds ratio were not useful for these samples, except for the Tlajinga 33 sample, because either adults or subadults completely lacked lesions at La Ventilla.

Table 15.1 summarizes the results for comparisons of status and the presence of lesions by age. Templo/Glifos had such small numbers for each status and skeletal indicator that these individuals are not included. As has already been noted, adults generally had various kinds of paleopathological lesions. For enamel hypoplasias, for example, three of the 12 high-status adults in the Artisans/Domestics sample were affected by hypoplasias (sub-

adults had none), while the Tlajinga 33 sample had few individuals that did not have a hypoplasia in either status. In general, Tlajinga 33, the lowest-status compound, had more individuals with lesions, except for porotic hyperostosis. In low-status individuals, 9 of 52 (17 percent, all adults) in the Artisans/Domestics compound sample had porotic hyperostosis, while the Tlajinga sample had 3 of 21 (14 percent, all children). It is noteworthy that only one age group is generally affected by a particular paleopathological indicator.

At Monte Alban, a smaller urban concentration, the prevalence of lesions indicating biological stress is generally low. The tomb individuals can be compared with the nontomb ones, although the sample sizes are small. For porotic hyperostosis, only three individuals of 81 (including 1 subadult) were affected, while only 1 male of 18 individuals buried in the tombs were afflicted (OR = 1.5, 95 percent CI = 0.15–15.3; not significant). Enamel hypoplasias were present in only 1 of 16 tomb settings and in 3 of 39 nontomb funerary contexts. Abnormal periosteal new bone was present in 2 of 16 burials in tombs and in 12 of 70 (17 percent) non-tomb burials. Three of 19 (16 percent) of tomb individuals (all males) and 11 of 87 (12 percent) nontomb burials were affected by broader, more systemic periosteal skeletal reactions. None of these comparisons yielded significant odds ratios. For comparison, tibial reactions affected 32–37 percent of the Teotihuacan individuals.

Discussion

The larger size of the Teotihuacan urban environment seems to have fostered greater morbidity and a more complex biological pattern among groups of different social status. In Monte Alban, the tomb individuals (high status) generally lack pathological lesions, while the nontomb individuals do manifest such lesions. Of course, these individuals were generally of a lower nobility or wealthy commoner status, so their socioeconomic status in the urban setting could have been very good. As hypothesized, in Monte Alban, internal status differences did not seem to affect the presence of the paleopathological indicators. Were these tomb individuals generally free of all pathological conditions, so that only a few individuals tended to have multiple pathological lesions? Or did different individuals have different pathologies? Depending on the answer, tomb individuals might have gone through much of their life without serious stress. This is a question for further research.

A slightly more concrete, though still preliminary, perspective into the patterning of multiple pathological conditions can be made at Teotihuacan. In the Artisan/Domestic compound, only 3 high-status adults had hypoplasias and none of these people had a tibial reaction. Among the low-status individuals in this compound, 3 individuals also had hypoplasias, but only 1 adult also had a tibial reaction. In Tlajinga 33, conversely, 15 high-status individuals suffered from hypoplasias and 7 also had tibial reactions (3 subadults, 4 adults). In the low-status individuals, 11 had hypoplasias and 5 (1 subadult, 4 adults) also had tibial reactions. In both status groups, nearly 45 percent of the individuals who could be scored demonstrated the co-occurrence of both pathological conditions. None of these were statistically significant, but the sample sizes are very small. More research will reveal if there is a pattern in which individuals from higher-status compounds generally exhibit only one form of skeletal stress markers and those from lower-status compounds often exhibit two stress markers or perhaps other manifestations of stress.

The relationship of status and health in contemporary societies has indicated that the higher one's socioeconomic status, the better one's health tends to be. In historically known urban societies, however, the density of populations and the resulting problems of nutrition, hygiene, and easier disease circulation produced health problems for all individuals, regardless of status (see Storey 1992).

We inferred status associated with people or groups by looking at the archaeological context. In pre-Columbian urban societies, status was closely linked to residential construction materials, location in the city, and the mortuary treatment of the individuals buried in the residences. However, the problem with using osteological indicators of health, which reflect mostly chronic conditions, is that it is not clear how their significance should be interpreted (Wood et al. 1992). Individuals have to survive stress for a time before lesions appear on bone. Thus, it should be remembered that morbidity indicates some resilience on the part of individuals.

Still, some preliminary generalizations about urban health in pre-Columbian central Mexico can be made. In the Early Phase, conditions in the city meant that individuals were more prone to the stresses that cause systemic skeletal infection and hypoplasias and that they had to survive them for at least some time. In contrast, the Late Phase had lower prevalence patterns, suggesting a change in exposure or in buffering. In general, about half of the adults had hypoplasias and about one-third of adults in all status groups had porotic hyperostosis that had healed, indicating survival

of childhood biological disruption. However, the most distinctive pattern is that the subadults had at La Ventilla had no paleopathological lesions, while adults at La Ventilla and subadults at Tlajinga 33 did have such lesions. This pattern could suggest that subadults in La Ventilla tended to die before any stresses could affect their skeletons or that what killed them did not affect bone (i.e., the cause of death was a more acute process).

While we hypothesized that higher-status compounds would be superiorly buffered against stress and disease, the evidence for this is unclear. It is true that the lowest-status compound (Tlajinga 33) had the highest prevalence of biological stress indicators and the more central and higher-status neighborhood of La Ventilla had less. However, the main difference involves the lack of paleopathological lesions among subadults in the higher-status compounds, which, as noted, may not indicate that they were healthier. While this is just a preliminary analysis, it also appears that the Tlajinga 33 individuals were afflicted with more than one type of lesion, while this was generally not the case in La Ventilla. The occurrence of multiple lesions in single individuals is perhaps where the real difference between high- and low-status compounds will be found. The Teotihuacan urban environment generally brought risks of morbidity for individuals, whatever their status.

It does appear that within compounds there is not much difference in the prevalence of these paleopathological indicators. There were few high-status subadults, indicating that rarely was status associated with youth, and there were generally no significant differences between adults. Thus, status appears to have been achieved rather than inherited. Individuals were subjected to similar health risks as children and to similar risks of infectious lesions as adults. The remains from Monte Alban also exhibited no significant differences between tomb and nontomb individuals within a residence, the same pattern as that at Teotihuacan.

Conclusions

Additional investigations of these skeletons are ongoing, but it appears that higher-status compounds were slightly more buffered against biological stress and disease, no matter what the internal variation of social status was among constituent residents. This provides initial support for the first model of social status and biological stress we proposed earlier in the chapter. Adults of the higher-status compounds did appear to have survived stress events as children, whereas all ages of the lower-status compound

tended to die with more paleopathological lesions. Lower-status adults, especially in Tlajinga 33, experienced and survived more than one form of biological disruption and stress before death, indicating a more stressful childhood (particularly in the form of enamel hypoplasias) and perhaps an elevated susceptibility to later infection and disease. This is the main difference by compound status that is present in these skeletal samples. Within-compound status differences, as defined by mortuary treatment, did not seem to be correlated with significant differences in the prevalence of morbidity. In addition, there are hints that individuals survived stress and expressed more lesions in the Early Phase than in the Late Phase. Did the city's health environment deteriorate to the point that individuals tended not to survive biological insults at the end of the city's lifespan? There are certainly hints of this in Tlajinga 33 (Storey 2006), but more research is needed. Clearly, these patterns of biological stress and disease only scratch the surface of the relationship between social status and human biology at Teotihuacan and Monte Albán.

Acknowledgments

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16

Middle Sicán Mortuary Archaeology, Skeletal Biology, and Genetic Structures in Late Pre-Hispanic South America

HAAGEN D. KLAUS, IZUMI SHIMADA, KEN-ICHI SHINODA, AND SARAH MUNO

Some 1,000 years ago, the Middle Sicán culture thrived along the coast of northwestern South America. This theocratic state-level society featured unprecedented scales of trade and economic productivity, a distinctive religious system, unmatched technological developments in metallurgy, and archaeological evidence of a significant and institutionalized gulf of socioeconomic wealth between its elite and non-elite citizenry. In this chapter, we integrate mortuary archaeology, skeletal biology, and biomolecular data to characterize the nature and structure of Middle Sicán socioeconomic differentiation and its relationship to biological stress and population genetic structures. We also seek to touch upon various theoretical and methodological points regarding the bioarchaeology of hierarchy and various cautions and ambiguities inherent in the study of skeletons from the Middle Sicán period and beyond.

Biocultural Constructions of Biology and Hierarchy

Human biology is profoundly multifaceted. Abundant evidence illustrates that within complex societies, a human being's socioeconomic standing is a powerful determinant of biological status throughout life (e.g., Collins et al. 2004; Crooks 1995; Dressler and Bindon 2000; Krieger 2008; Nguyen and Peschard 2003; Rosenswig 2000; Saplosky 2004; Singh and Yu 1996; Smith et al. 1996a, 1996b; Victorino and Gautier 2009). Bioarchaeological research has been strongly influenced by materialist thought that describes

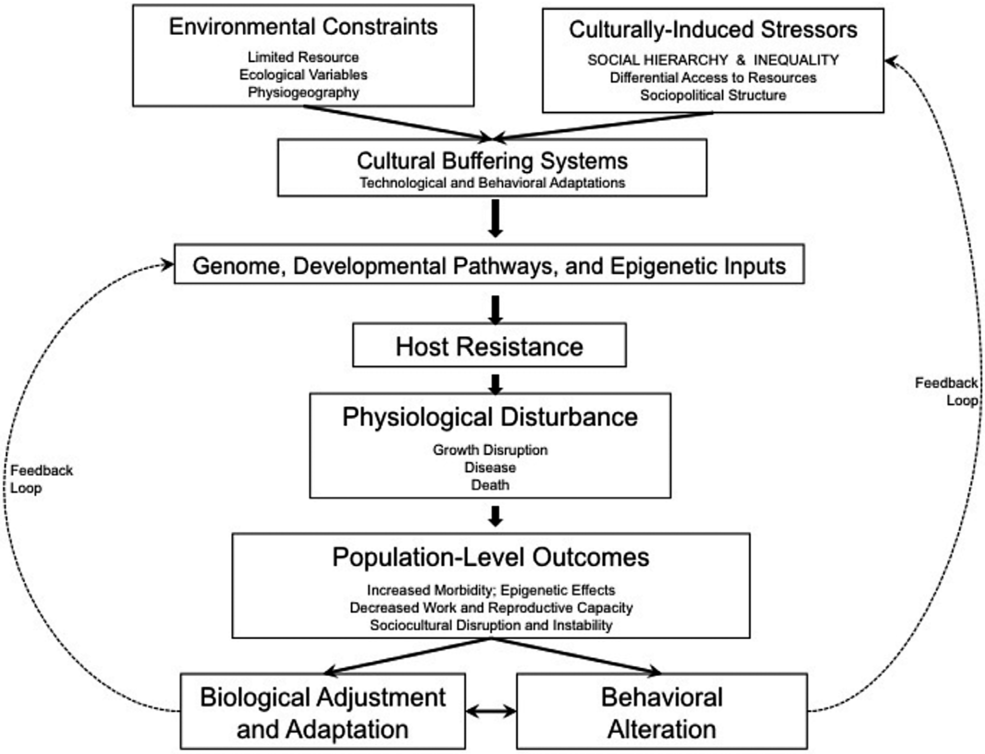

Figure 16.1. A model of biocultural relationships as shaped by social hierarchy. Drawing by H. Klaus.

socially prescribed differential access to resources such that the perspective of a political economy of human biology is particularly useful (Goodman and Leatherman 1998; Saitta 1998). The biological stress model Goodman and colleagues (Goodman et al. 1984; Goodman and Martin 2002) developed and revised considered how resource availability impacts nutrition and related factors such as pathogen-free drinking water, population density, the quality and quantity of arable land, and sociopolitical capital. Fig. 16.1 illustrates the hierarchical impacts of unequal access to food, water, shelter, climatic variables, parasites, and predators that impact resistance to disease and longevity. All of these are potential ecological constraints to adaptation. Cultural systems such as shelter, clothing, and economic strategies buffer against stressors, but cultural systems such as social hierarchies introduce a host of stressors (Schell 1997) that can powerfully influence the rest of the relationships envisioned within the stress model.

When insufficient buffers are present against environmental and cultural constraints, stress is passed along to the biological population. Expression of biological stress in hard tissues depends on levels of host resistance. Population-level outcomes can include increased morbidity, depressed growth, decreased reproductive fitness, and social disruption. Behavioral adjustments to increased stress can attempt to offset stress as a downstream buffer in a recursive way. Thus, stress in any setting cannot be seen in terms of simplistic or linear causes and effects, but as a series of interactions among nested layers of causalities related to the interplay of humans with their environment, developmental processes, cultural constructions, and human action (e.g., Gravelee 2009, Figure 3).

Moreover, we concur with Reitsema and McIlvaine (2014) and Temple and Goodman (2014) that it is impossible to measure health from skeletal remains. "Health" is a complex, holistic function of individual perception of well-being, physiological well-being, mortality, daily functioning, and community interactions, all of which are factors at the crossroads of evolutionary and biocultural approaches in anthropology. "Health" is also quite difficult to quantify, and the skeleton is but one component of this broader reality. Instead, skeletal lesions can be more accurately and properly envisioned as products of biological stress, allostatic overload, and disrupted physiology that reaches the skeletal system. One can argue that when skeletal lesions are present, biological stress is a manifestation, but not the cause, of functional impairment (Temple and Goodman 2014).

Because human skeletal biology is a product of underlying genes and lived experiences, bioarchaeology can connect biological and archaeological evidence to reconstruct how variations in biological stress are shaped by social structure through time and on regional or global scales. Application of the logic of the stress model in Fig. 16.1 has demonstrated a fairly clear, though still preliminary, picture of stress variation in complex societies. In general, higher-ranked social strata tend to be associated with lower degrees of biological stress and lower-ranked strata are associated with greater degrees of stress outcomes. This evidence is well established for the patterning and prevalence of phenomenon such as linear enamel hypoplasias, porotic hyperostosis, growth disruption, oral health, degenerative joint disease, nonspecific infection, and specific infectious processes, including tuberculosis and leprosy (see Larsen 2015; Danforth 1999; and Goodman and Martin 2002 for comprehensive literature reviews; also Cohen 1998; Goodman 1998; Stone et al. 2009; and various chapters in this volume). Studies of prehistoric and modern hierarchy also demonstrate

biological stress inequalities between core regions (where socioeconomic power is concentrated) and areas that lacked political autonomy and control over the means of production (Goodman 1998; Humpf 1992; Klaus and Tam 2009, 2010; Márquez Morfín 1998; Van Gerven et al. 1981, 1995; Zhou and Corruccini 1998).

There are at least three principal cautions associated with the vision outlined above. First, the simplistic and blind-faith assumption of "less stress = wealth" is a one-dimensional, static concept that oversimplifies the biocultural components of stress. As Saitta (1998) notes, morbidity and social class cannot be taken as a straightforward reflection of social structure or political economy. Relationships between biological stress and social organization can be complex or ambiguous (Panhuysen 2005; Robb et al. 2001). Preferential access to nutritional resources can also have negative effects. A high-status group may consume more meat and enjoy a greater bioavailability of iron, but this can predispose them to hyperuricemia (gout) or increased susceptibility to tuberculosis infection (Wilbur et al. 2008). Second, models of supraordinate and subordinate interactions might deemphasize the agency of lower socioeconomic strata, envisioning them as passive cogs in a social system doomed to a fate of greater morbidity. The agency, inventiveness, and behavioral adjustments of subaltern groups must be carefully considered, as people clearly and actively respond to challenges that emerge from unequal power relationships (Dillehay 2001; Klaus and Tam 2010; Stein 2005; Stojanowski 2010). Third, interpretations of biological stress can find themselves in meta-typological dilemmas when social structure is evaluated according to simple categories of "high"- versus "low"-status burials (Temple and Goodman 2014). A number of chapters in this book, including this one, grapple with this issue. However, such a meta-typology may be forgiven if: 1) it generally approximates the structure of ancient social differences or 2) it is the starting point for the development of increasingly complex frameworks for evaluating biological stress and social structure. Both conditions apply to our work here.

Hierarchy and Biological Stress in the Middle Sicán State of Ancient Peru

Archaeological Setting

The arid Lambayeque Valley Complex on the north coast of Peru (Fig. 16.2) was an independent center of complex Andean societies as seen in

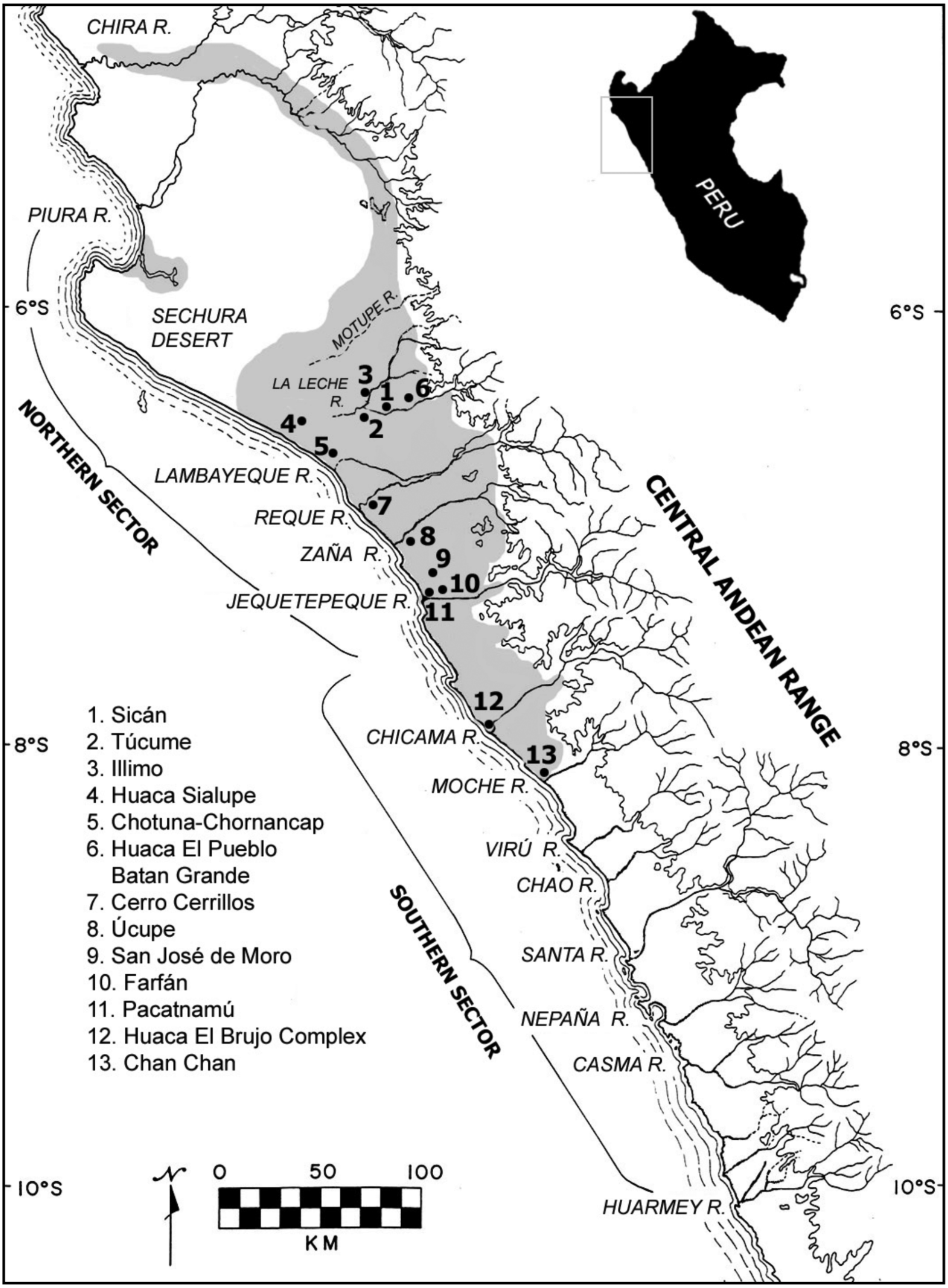

Figure 16.2. The north coast of Peru, including sites discussed in the text. Map by H. Klaus, redrawn from an original by Izumi Shimada.

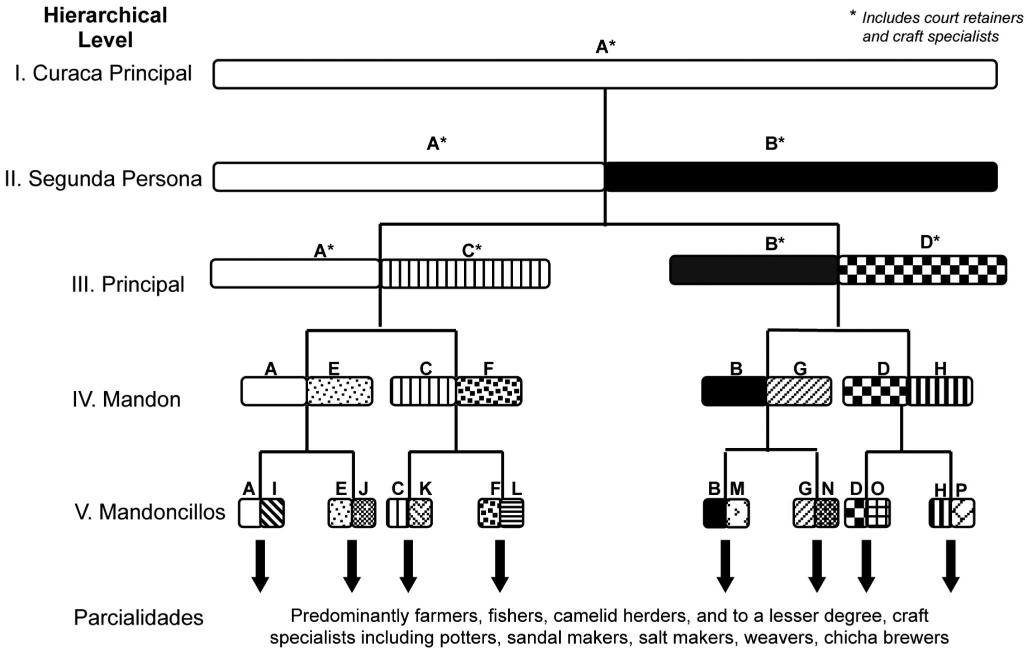

Figure 16.3. Schematic diagram of hierarchical *parcialidad* organization, as reconstructed from archaeological and ethnohistoric evidence. Drawing by H. Klaus, based on Netherly (1990) and Shimada (2001).

the prominent cultural developments of the Cupisnique (1500–650 BC), Moche (AD 100–750), and Sicán eras (AD ~800–1375; also called the Lambayeque Culture). Later, the region became a key holding of the Chimú (AD ~1375–1470) and Inka empires (AD ~1470–1532). At least since late Moche times in the sixth to eighth centuries AD, north coast societies were organized as hierarchical stratified polities.

Mortuary patterns in particular suggest that during the Moche era, small groups of powerful elites occupied the different valleys of the north coast and ruled over at least two subordinate classes (Shimada 1994, 1999). These subalterns may have consisted of several ethnic groups that were to varying degrees integrated into the Moche political economy and belief system (Bawden 2001; Bourget 2003; Chapdelaine 2008). The social organization of north coast societies dating back at least to the Late Moche period involved a dualistic, hierarchical socioeconomic system that the early Spanish colonists called a *parcialidad* (part of a whole) (Netherly 1990; Ramírez 1981; Shimada 1994, 2001). *Parcialidades* were organized according to kinship and economic specialization (Fig. 16.3). Successively higher levels of

nested organization were associated with increasingly ranked pairs of nobility and their communities that culminated in a single position of the *curaca*, or lord.

Ecological and ideological strain led to the political disintegration of Moche culture around AD 750 (Shimada 1994; Bawden 2001). The Sicán culture emerged from this around AD 800–900 in the La Leche drainage. The florescent Middle Sicán (or Classic Lambayeque culture; AD 900–1100) rose swiftly to regional prominence. Middle Sicán growth and influence was based not on militaristic expansion but rather on the development of unprecedented trade networks, a creative and robust subsistence economy, and the peri-industrial production of copper-arsenic alloys and precious metals. All of this was organized by a segmentary theocratic state that featured an elite ancestor cult and monotheistic religion at its core (Shimada 1990, 1995, 2000, 2014a; Shimada and Samillán 2014).

Mortuary Evidence of Middle Sicán Social Hierarchy

Various lines of evidence attest to the hierarchical character of Middle Sicán social organization, which involved a four-tier hierarchical settlement system (Tschauner 2001) and the presence of three distinct production spheres based on the degree of administrative supervision and an ascribed value of metal and ceramic products (Cleland and Shimada 1998, 137). Middle Sicán representational art provides more direct evidence of institutionalized differentiation. For example, Middle Sicán art includes a sculptural representation (Fig. 16.4) of an elite male personage carried on a litter that is seen in short-hand renditions in black pottery or in metalwork. The personage and the porters differ notably in size and in the complexity of their clothing and ornaments and the metals used to represent them—gold and silver alloys for the personage and silver alloys for the porters. These and other observations are the bases for adopting the representationist approach as the general guideline for interpreting Middle Sicán mortuary practices (Brown 1995; Shimada et al. 2004). In other words, material dimensions of mortuary treatment, such as the quality and quantity of funerary goods, generally reflect the social position of the deceased as opposed to distorting or misrepresenting it. But instead of blindly applying these guidelines, our interpretative efforts have been moderated by the multiple strands of independent lines of evidence generated by our interdisciplinary investigation (see below) and a keen awareness of the multiple factors that could have shaped any given mortuary treatment (see McHugh 1999; and Parker Pearson 2000 for overviews of this debate).

Figure 16.4. Middle Sicán gold alloy sheet-metal object representing the Sicán Lord being carried on his litter. The Gold of Peru Museum. Photo by I. Shimada.

After establishing Middle Sicán chronology, ecology, and technology over 12 years of research, the Sicán Archaeological Project turned to the long-term, interdisciplinary analysis of social organization, mortuary practices, and population biology in 1990. Securing an adequate sample of well-preserved, socially representative, and contextualized funerary contexts in the regional population has been a major challenge. The organized and intensive grave looting that began in the 1930s continued unabated until 1969. This looting targeted and partially or totally destroyed countless funerary contexts (Carcedo and Shimada 1985). A truly representative sample of archaeological funerary contexts is "to a large degree unachievable since

	First Tier: High Elite Males	First Tier: High Elite Females	Second Tier: Low Elite Males	Second Tier: Low Elite Females	Third Tier: Commoner	Fourth Tier: low status commoners; captives?
GRAVE GOODS						
High-karat gold alloy objects	◆	◆				
High-silver-copper alloy objects	⬩	◆				
Low-karat gold (*tumbaga*) and/or gilt copper objects	◆	◆	◆	⬩		
Silver-gilt copper objects		◆		◆		
Cinnabar paint	◆	◆	◆	◆		
Semi-precious stone beads	◆	◆				
Amber	◆			⬩		
Shell beads	◆	◆	◆	◆		
Spondylus princeps	◆	◆	⬩	⬩		
Conus fergusoni	◆	◆				
Double-spout bottles	◆	◆	⬩	⬩		
Single-spout bottles	◆	◆	◆	◆	◆	
Copper-arsenic objects	◆	◆	◆	◆	◆	
Utilitarian plain and *paleteada* pottery			◆	◆	◆	◆
Ochre paint					◆	
BURIAL POSITION						
Seated	◆	◆	◆	◆	◆	
Extended			◆	◆	◆	◆
Flexed					◆	◆

Figure 16.5. A provisional four-tier model of Middle Sicán social hierarchy based on 35 years of cross-contextual and regional sampling. Prepared by I. Shimada.

the target population is not accessible" for many reasons (Shinoda et al. 2010, 252; Drennan 1996, 86).

However, a detailed study of literally thousands of looted Middle Sicán funerary contexts and carefully designed sampling strategies of intact high-status funerary contexts at Sicán and of non-elite cemeteries at other Middle Sicán sites have been complemented by the findings by various projects conducted by our Peruvian colleagues to generate some 214 scientifically excavated burials. From these findings, we compiled a provisional four-tier model of social hierarchy (Fig. 16.5). The model is continuously being refined and no doubt still underrepresents the complexity of social differentiation.

In our model, access to different types of metals appears to have been a consciously employed marker of status. Only "high elites" had access to the full range of alloys Sicán metallurgists produced, which included high-karat gold alloys (≥ 12 karats) and alloys composed of gold, silver, copper, and/or arsenic. "Low elite" individuals had access to all alloys *except* high-karat gold alloys but acquired the highly valued "goldness" by gilding copper-arsenic objects and/or enriching surface gold concentrations of lower-karat gold alloys (< 12 karats; commonly called *tumbaga*) by selectively depleting (pickling) copper and/or silver. High elite females had access to silver and silver-gilded objects, while low elite females had access only to silver-gilded objects. Copper-arsenic alloys were the only metal items available to third-tier "commoners." The fourth tier is tentatively defined on the basis of a few burials that were accompanied by no metal objects at all (or any other grave goods, for that matter).

Inferred high elite individuals were found in two deep shaft tombs called East and West Tombs at the north base of the Huaca Loro mound (Fig. 16.6), symmetrically placed at the base of the 150-meter-long North Platform. The longitudinal north-south axis of the temple complex runs through this platform (Fig. 16.5; Shimada 1995; Shimada et al. 2000). The East Tomb, which was excavated in 1991–1992, was a 3 × 3 m square, 12 m deep vertical shaft with a funerary chamber at the bottom. The contents were found arranged concentrically in three levels on, around, and beneath the cinnabar-painted and bundled remains of a robust, 40- to 50-year-old male. Two young adult women, one of high elite and the other of low elite status, and two juveniles (one of low elite status of indeterminate sex and ca. 12–13 years of age and another of ca. 5–6 years of age) accompanied him. His body, which had been arranged in a cross-legged, inverted seated position with his hands on his chest, and centrally placed on a floor covered

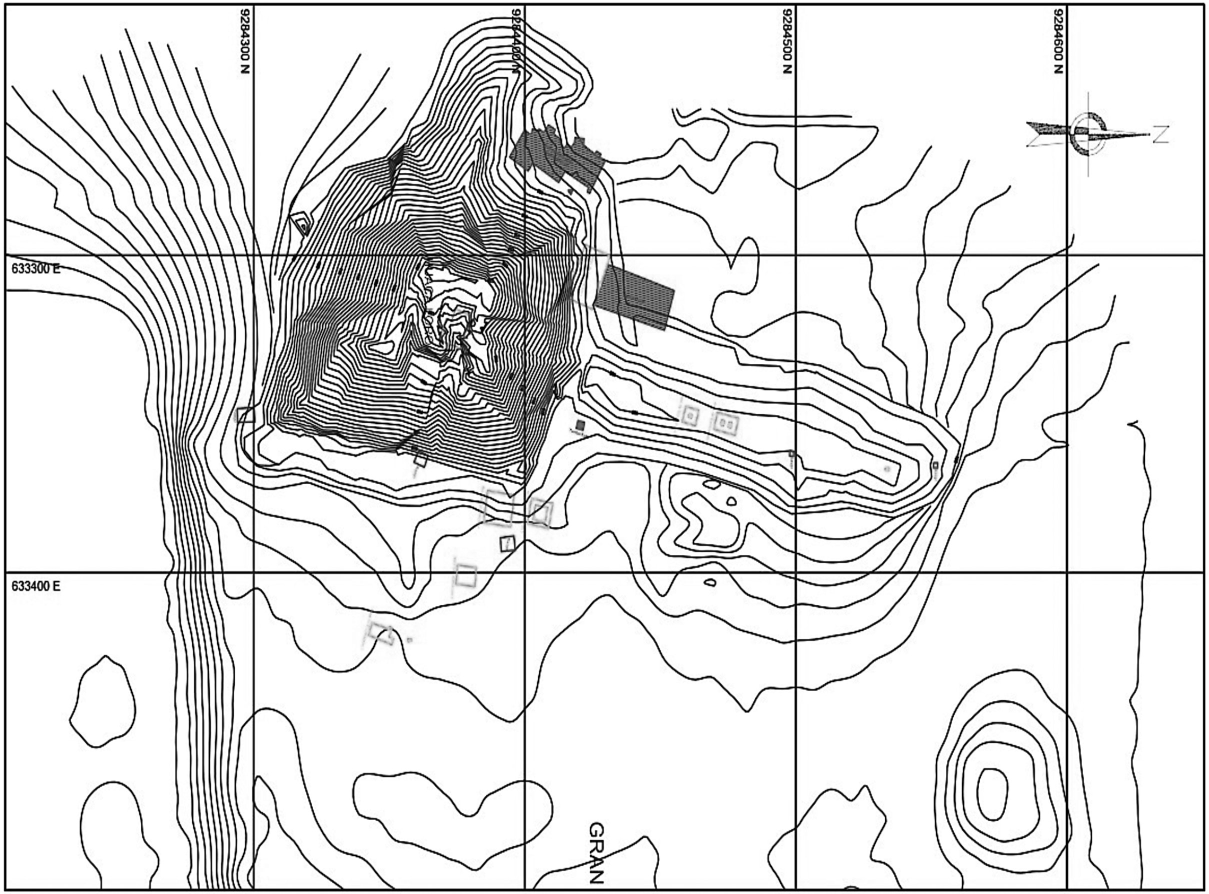

Figure 16.6. Topographic map of the Huaca Loro temple mound with locations of excavations carried out from 1991 to 2008. Courtesy of L. Caceres.

with a woven mat (Fig. 16.7). He was buried wearing and surrounded by high-karat gold ornaments, including a *tumi* (a ceremonial knife) next to his left hand, a pair of shin covers next to his crossed legs, a hinged backflap over his hips, and at least three layers of amber, amethyst, shell, and other bead pectorals on the chest. His head had been detached after death and rotated so as to be right side up and placed in front of the body looking west. A masterfully prepared, large 14-karat gold mask and two pairs of large gold ear ornaments covered his face and ears, respectively.

Other items symbolic of his status included a tall standard that is inferred to have been displayed in processions, two gold alloy dart throwers, and a pair of metal gloves 90 cm long placed in front of the body, the left of which held a gold and silver rattling cup and the right of which rested atop a tall staff. The standard and the cup were both decorated with repoussé images of a standing male personage wearing the same kinds of ornaments and holding an identically shaped staff and cup in his hands as the individual we excavated. We believe these and other similar depictions of a male personage found on objects in this tomb represented the actual principal individual of the tomb. Overlying his remains were the disassembled parts of his litter covered with *tumbaga* sheets. Another glimpse of the material prerogatives high elite individuals enjoyed can be discerned when one estimates the material and human resources represented in the manufacture of tens of thousands or some 80 kg of shell and semiprecious stone beads (e.g., quartz, amethyst, and turquoise), some 200 kg of copper-arsenic implements, and a half metric ton of scraps of predominantly hand-forged *tumbaga* sheets (typically 0.1 mm thick and with an average composition of 13 percent gold, 30 percent silver, and 57 percent copper).

The East Tomb also appears to have featured a carefully arranged choreography that reveals its basic intent. The high elite woman was arranged lying on the floor with her arms and legs splayed open, reminiscent of a position assumed for childbirth, while the low elite woman sat with her hands placed in front of the pelvis of the former as if to receive a newborn—probably as a symbolic enactment of the rebirth of the deceased male leader or his transformation into a supernatural ancestor. The intense red cinnabar painted on his entire corpse was probably intended to impart some kind of life force to a dead body in Middle Sicán symbolic thinking.

The West Tomb, which was excavated in 1995–1996 (Shimada 1995; Shimada et al. 2000, 2004), was a physically imposing, complex two-tier nested construction—literally a shaft tomb within a shaft tomb (Fig. 16.8). A 10 × 6 m "antechamber" lay 12 m below the surface and a 3 × 3 m central

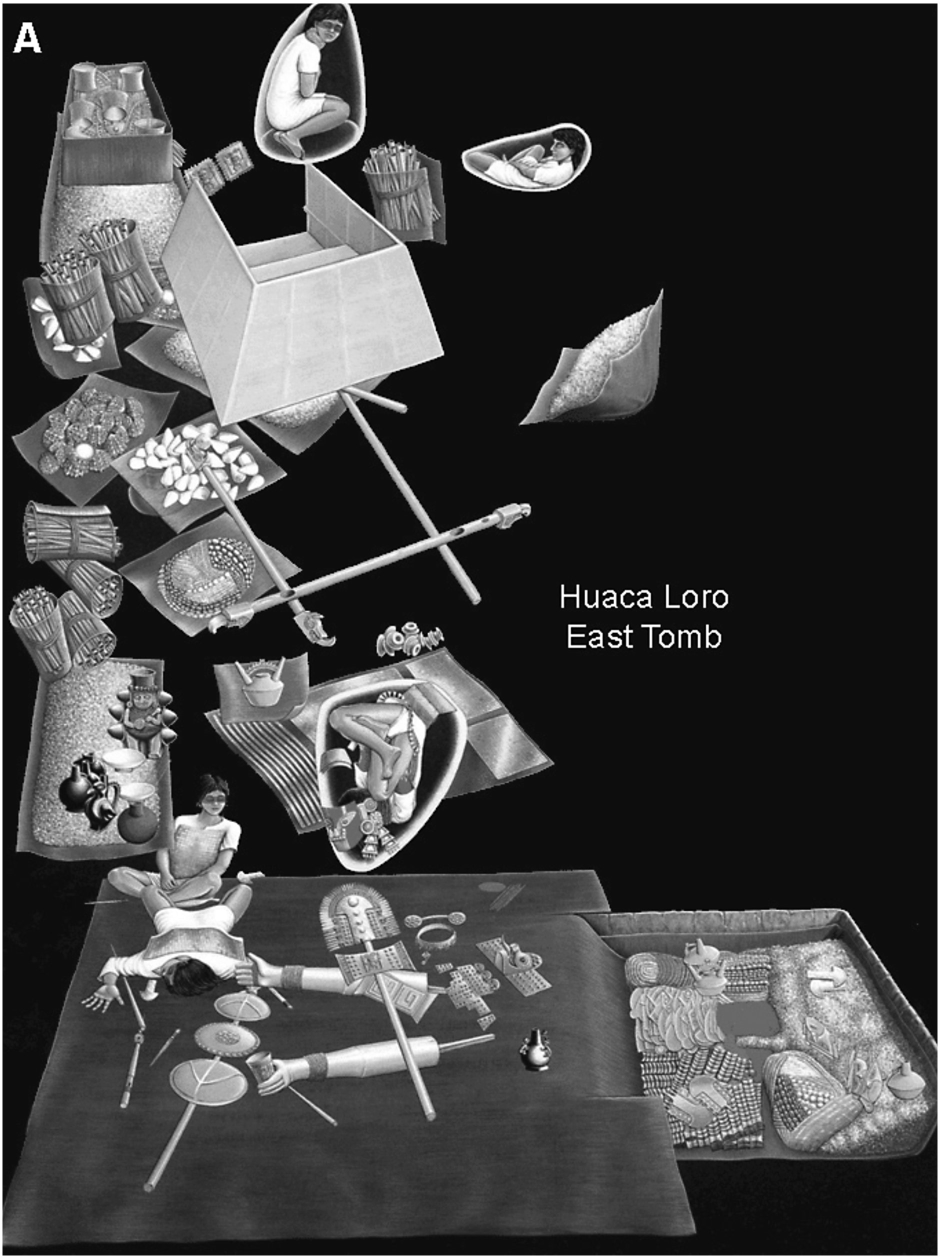

Figure 16.7. An exploded view of the high-elite Middle Sicán Huaca Loro East Tomb, which was filled with 1.2 tons of precious metals and other prestige items. Painting by Cesar Samillán and Izumi Shimada.

shaft descended an additional 3 m to the floor of the Central Chamber, which contained the seated and cross-legged remains of the high elite male personage and diverse funerary goods. This individual was a robust man of around 40 years of age. His accoutrements and emblematic objects largely duplicated in kind those of the East Tomb, but they differed notably in material, technical attributes, and artistic quality. Only a handful of high-karat gold objects (a nose clip and a tunic binding clip) were found. The mask he wore was similar in design and size to that of the East Tomb, but it was fashioned out of two joined *tumbaga* sheets rather than from a single, large high-karat gold sheet. The latter would have demanded tremendous skill and effort, as is the case with the East Tomb mask (Shimada and Griffin 1994). A badly corroded *tumbaga* rattling cup with repoussé images of a standing personage was held in the right-hand glove, in contrast to the case of the East Tomb, where the personage held the rattling cup in the left hand. Considering representations of toasting in Middle Sicán art, the use of the right versus the left hand position for toasting with the cup may well have represented a subtle but important heterarchical social differentiation (see Cummins 2002); the latter (East Tomb) is inferred to have been superior.

The West Tomb antechamber had ten wall niches. Two of these contained a young adult female and one central niche contained a 12- to 13-year-old child. Twelve small rectangular subfloor pits were laid out in two symmetrically opposing groups of six each on the north and south sides of the central chamber. It is possible that at least some were victims of sacrifice (Klaus and Shimada 2016). Each pit contained one or two skeletons of young adult women (most of whom were 18–22 years old at death) (Farnum 2002), so that each group, referred to as the North and South Women, consisted of nine women. Most were in a seated/flexed position and were accompanied by a few grave goods, which included broken ceramic vessels, textiles, copper-arsenic objects, and chalk (*tiza*). As the ceramics and painted textiles accompanying the North Women had a strong affinity to the earlier Moche style, their patterns of inherited dental traits independently suggest an affinity to the local population (Klaus 2008), we hypothesize that they represented a Muchik ethnic group that descended from the earlier Moche peoples. In contrast, the South Women were accompanied by exclusively Sicán-style goods and appear to be closely related to the principal personage both in terms of dental traits and mtDNA variation, suggesting that they belonged to an ethnic Sicán population (Corruccini and Shimada 2002; Shimada et al. 2004). The planned organization of the West Tomb symbolized not only the gulf that existed between people of

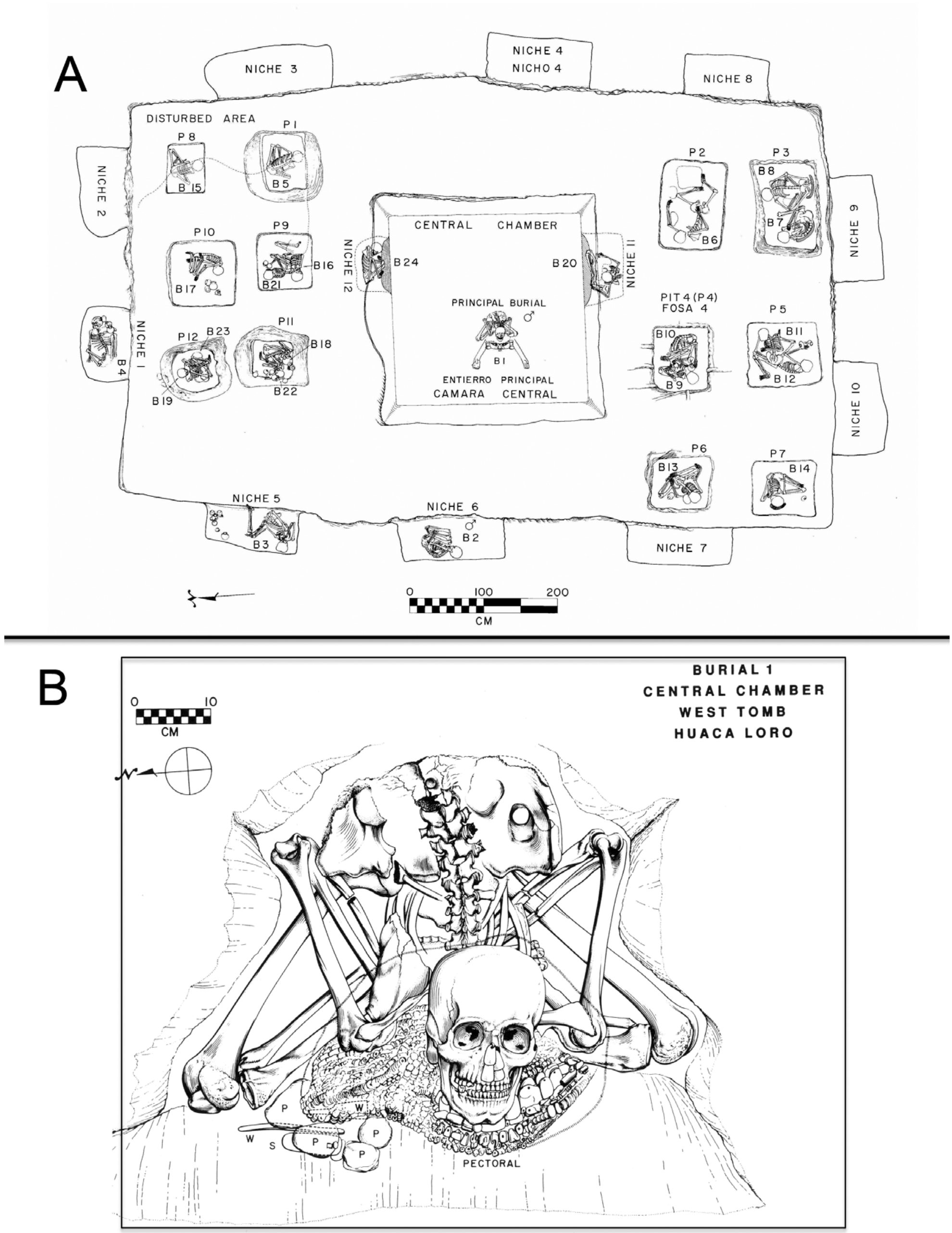

Figure 16.8. A: Symmetrical placement of the 24 individuals in Huaca Loro West Tomb. B and P represent burial and pit, respectively. B: Detail view of the principal personage in the Huaca Loro West Tomb, found on the floor of the central chamber three meters below the floor of the antechamber. Drawings by I. Shimada and C. Samillán.

different social status but also the integration of at least two ethnic groups under the Sicán leadership (i.e., the principal personage).

The 2006 excavation of the Huaca Loro West Cemetery documented 24 funerary contexts that attest to the high social standing that some women enjoyed. Two tombs were exceptionally large and complex; these were designated West Central Tombs 1 and 2. Tomb 1 was a 3.5 × 3.7 m and 5 m deep shaft tomb dating to the Early Middle Sicán era (ca. AD 1000). The contents of the funerary chamber at the bottom of the shaft were organized around a central, seated, and cross-legged woman 20–25 years in age who was buried with an adult female companion. Two infants were buried at the mouth of her tomb at the time it was sealed. Later, at least five lesser graves containing adult males and females and a cache offering of sumptuous goods were placed at the mouth of the tomb over a 50- to 100-year period following her interment, suggesting a lasting social bond with and memory of this elite woman.

West Central Tomb 2, situated 12 m south of Tomb 1, featured a 7.3 × 3.2 m rectangular area 1.5 m in depth that was longitudinally partitioned into three levels. What appears to be a painted cloth on a cane frame that was circa 1.4 m wide and over 10 m long covered diverse sumptuary grave goods partially covered with cinnabar paint on the floor of the upper and middle levels. These goods included a small gold ingot, diverse copper-arsenic objects, llama heads and feet, over 1,200 miniature vessels, and 12 fine decorated ceramic bottles that stylistically date to the late Middle Sicán, circa AD 1050–1100. The north end of the lower level extended downward to another level and contained two nested burial chambers, Chambers 2 and 3. The larger of the two, Chamber 2, was prepared first and contained what remains of an elaborate early Middle Sicán burial that was disturbed in ancient times. This burial included a partial skeleton of the inferred principal personage (a child) and a sacrificed female adult.

Clearly there was a great deal of variability in mortuary context organization among and between the high and low Middle Sicán elites. No single elite funerary context is a copy of another. While there were deep rules and ritual grammars that were closely followed, other aspects of burial ritual appear to have had an almost individualized character, and it is likely that degrees of social and political competition existed among the elite in life and death, manifesting here in terms of mortuary variability. However, they are united in the consistent use of gold, silver, and gilded copper-arsenic items; masked, seated, and flexed male principal personages accompanied by the image of the Sicán Deity; access to cinnabar; and so forth.

Comparisons between these elite mortuary patterns with Middle Sicán commoners present striking dichotomies. Outside the capital of Sicán, commoner communities were numerous. They were likely organized according to the principles of the *parcialidad* system (see below and Netherly 1990; Ramírez 1981; Shimada 2001) and included groups of economically specialized fishers, farmers, ceramic artisans, metal smiths, and llama herders. Huaca Sialupe Burial 01-5, a man of about 35–45 years of age, is a context representative of local peoples (Fig. 16.9A). He was interred in a small cemetery on the flanks of a multi-craft workshop. The body was placed on a north-south axis with the head at the south end of the burial pit. He was buried with a limited number and variety of objects that included a single undecorated ceramic vessel, a small textile bag containing a simple copper-arsenic bowl, and an object possibly made of copper and arsenic placed in the mouth.

Other burials in the region, such as those at Sicán (Cleland and Shimada 1992; Farnum 2002; Shimada 1995), Huaca del Pueblo Batán Grande (Cleland and Shimada 1992; Farnum 2002), Illimo (Klaus et al. 2004), and Túcume (Narváez 1994), feature a mix of similar or somewhat more materially varied funerary contexts than Huaca Sialupe Burial 01-5, but they follow consistent parameters of commoner burial rituals (Fig. 16.9b). Limited access to metal—only copper arsenic or no metal at all—is the universally unifying characteristic. Other elements of the commoner pattern include multiple ceramic vessel offerings. These sometimes included blackware pottery bearing the Sicán Deity image but most often they involved utilitarian wares that never exceeded more than ten pieces in a grave. Up to a few sets of camelid extremities were included in a number of commoner burials, probably reflecting a feasting ritual associated with burial (Shimada and Shimada 1997). Instead of using shaft tombs or burying their dead wearing material adornments, bodies were wrapped in simple woven cotton shrouds (occasionally dyed red or blue) and placed in simple pits that never extended more than 2 m in any dimension. A small number of burials with copper-arsenic objects were found in a seated and cross-legged position, a fact that complicates any clear-cut assessment of social organization and identity. In the case of rural craft production workshops such as those at Huaca Sialupe or Huaca el Pueblo Batán Grande, burials in the seated cross-legged position may reflect status emulation or a close association with Sicán leadership and may indicate that those individuals enjoyed a somewhat higher status. Seated commoners are consistently buried with ceramic bottles that bear the image of the Sicán Deity.

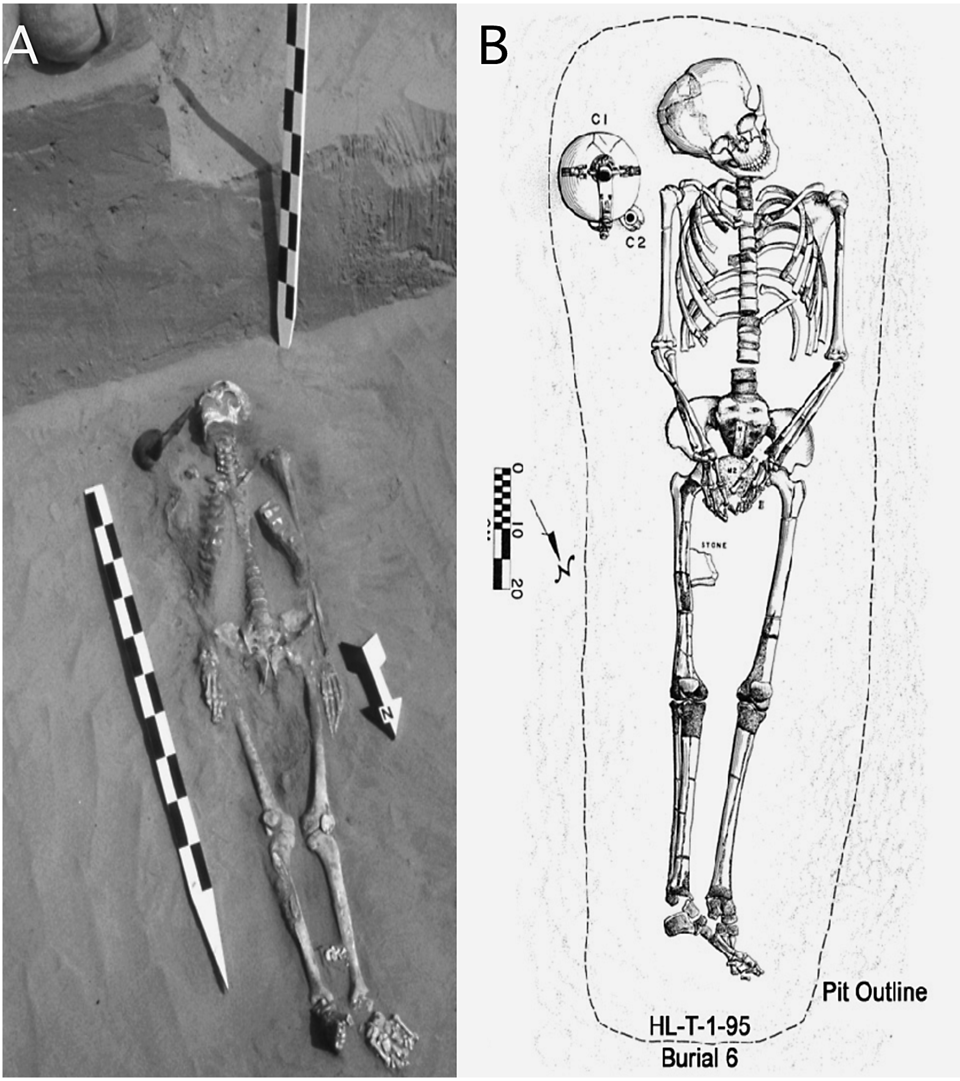

Figure 16.9. A: Huaca Sialupe Burial 01-5, photo by H. Klaus. B: Huaca Loro HL-T-1-95 Burial 6, drawing by Rafael Vega-Centeno and Cesar Samillán.

Multiple lines of evidence suggest that the majority of the commoners were ethnically Muchik—descendants of the earlier Moche population—and remained strongly connected to a traditional identity that was maintained through the practice of established mortuary rituals and material culture (Klaus 2008, 2014a; Shimada and Wagner 2007; Taylor 2002). In contrast with burials of the elite ethnic Sicán, burials documented in coun-

tryside Muchik communities—and even in the Middle Sicán heartland—demonstrate a strong continuity with earlier Moche mortuary traditions. Middle Sicán commoner burial—which featured an extended body position, alignment to a cardinal point (most often north-south with the head in the south of the grave pit), and burial with copper items, ceramic vessels, and llama offerings—appear to reveal the persistence of a formal mortuary pattern that emerged during the early Moche period (Bawden 2001; also Donnan 1995; Millaire 2002).

Biological Corollaries of Middle Sicán Social Hierarchy

Materials and Methods

Methods from paleoepidemiology, quantitative population genetics, and molecular genetics are used here to assess potential consequences of Middle Sicán social hierarchy. But as noted earlier, even with carefully constructed representative sampling strategies, there are many intrinsic and extrinsic challenges for a bioarchaeological study of hierarchy. However, if the four strata are collapsed into elite and non-elite social categories, the samples increase (Table 16.1) to acceptable sizes for various types of statistical analyses. The intention is not to artificially dichotomize social status, but considering the discontinuities between the simplest low elite burial and the most ornate commoner burial, it is a justifiably appropriate level of comparison. Also, the majority of the individuals in the elite category have been previously inferred as ethnic Sicán. Almost all of the individuals in the non-elite or social commoner category are inferred to be ethnically Muchik *sensu lato* by various criteria (see above). We strongly caution, though, against the assumption that they are all Muchik or that they all robotically practiced a monolithic group identity. Lumping together all "commoners" as defined by access to metals may obscure intragroup variability and identities. Currently, such variability is hinted at by various lines of evidence that suggest some kind of subcultural presence in Middle Sicán society associated with the Tallán, Gallinazo, or *paleteada* (paddle and anvil) ceramic production style (Millaire and Morlion 2009; Shimada 1994; Shimada and Maguiña 1994). In sum, analysis on the level of a basic elite/non-elite distinction is the least problematic level of analysis.

We compared four primary categories of skeletal phenomenon. First, we reconstructed systemic biological stresses using four variables: 1) linear enamel hypoplasias, which represent childhood metabolic stress that

Table 16.1. Middle Sicán period skeletal samples used in this study

Site	Date	N	Social context	Source
Huaca Loro East and West Tombs; West Cemetery, NE Tombs 1 and 2	AD 1000–1050/1100	45	Ethnic Sicán elites	Farnum 2002; Muno 2009
Huaca Loro West Tomb, Huaca las Ventanas	AD 1000–1050	35	Inferred high-status ethnic Muchik	Farnum 2002
Huaca del Pueblo Batán Grande	AD 900–1100	9	Inferred low-status Muchik craft producers	Farnum 2002
Illimo	AD 1000–1050/1100[a]	1	Lower echelon elite Muchik lord	Klaus 2008
Illimo	AD 1000–1050/1100[a]	30	Low- to middle-status Muchik commoners	Klaus 2008
Huaca Sialupe	AD 1000–1050/1100	15	Low- to middle-status Muchik craft producers	Klaus 2008
Huaca Cao Viejo, El Brujo Complex	AD 1000–1050/1100[a]	50	Comparative Lower Chicama Valley low- to middle-status Muchik population	Farnum 2002
Cerro Cerrillos	ca. AD 900–1375(?)[a]	32	Muchik sacrifice victims	Klaus et al. 2010

[a]While many of the sites here are securely dated using multiple calibrated radiometric assays, several others have been assigned chronological position based on decorated grave goods and stratigraphic location. The seriation of these stylistic elements into major cultural/chronological phases is validated by past radiometric dates (Shimada 2000).

results in bands of decreased enamel thickness on teeth and are associated with more acute forms of childhood stress including infection, inadequate nutrition, and diarrhea (Goodman and Rose 1991); 2) porotic hyperostosis lesions in the cranial vault that indicate chronic childhood anemia (Walker et al. 2009); 3) terminal adult stature, which is well known to vary with nutritional environment and socioeconomic status (Bogin and Keep 1999; Floud et al. 1990); and 4) nonspecific periostosis, or chronic nonfatal in-

fection of the adult tibiae, which provides a baseline of community-level immunocompetence and hygienic conditions (Larsen 2015).

Second, we reconstructed diet through the study of the interrelated pathological conditions of dental caries and antemortem tooth loss (Hillson 2008), which are linked to the consumption of carbohydrates. Third, we derived inferences about habitual movements and motions of joints and the intensity of physical activity from patterns of degenerative joint disease of the principal load-bearing joint systems (Hemphill 1999; Merbs 1983). Diagnostic procedures and differential diagnoses are discussed in extensive detail elsewhere (see Klaus and Tam 2009, 2010; Klaus et al. 2009). Fourth, we examined the genetic structure of populations from variation of inherited tooth size using standard population genetic analyses to estimate heterogeneity and gene flow (Klaus 2008; Stojanowski 2004) and from variations in the frequency of mtDNA haplogroups (Shinoda and Shimada 2009).

Quantitative comparisons of elite and non-elite skeletal biology are based on work by Farnum (2002) Klaus (2008), Shimada et al. (2004), and Muno (2009). These studies used descriptive statistics that point to greater degrees of biological stress among the lower-status population as measured by crude prevalence rates. However, crude prevalence can be subject to various kinds of skewedness, especially in terms of age variation across samples (Klaus 2014b; Waldron 2007). Here, we use age-related multivariate common odds ratios (ÔR) and maximum likelihood chi-squared or G-tests (for computational details, see Waldron 2007; Sokal and Rohlf 1995; Klaus and Tam 2010; and Klaus et al. 2009). We reconstructed terminal adult stature using standard regression equations (Genovés 1967) applied to femoral length. Population genetic analysis parameters were estimated using Relethford and Blangero's (1990) *R*-matrix based on inherited tooth sizes of maxillary and mandibular polar teeth (Klaus 2008). Sex estimations were based on standard morphology of the os coxa and the skull, and age was computed using the summary age statistic derived from multiple indicators, from which six age classes were derived (see Klaus and Tam 2009). All computations were carried out in International Matrix Language using custom programs written in SAS 9.1 (SAS Inc. 2003). Mitochondrial DNA was amplified from tissue derived from a single well-preserved tooth from each sufficiently preserved individual (see Appendix in Shimada et al. 2005 for methods).

Results

Our comparison of elite and non-elite or commoner Middle Sicán contexts demonstrate distinct, statistically significant biological differences (Table 16.2). Linear enamel hypoplasias affecting anterior teeth were 7.0 times more common among the non-elite, indicating systematic biological stress for this population. Porotic hyperostosis prevalence was 4.54 times greater among commoner peoples. The frequency of bilateral periosteal lesions on the tibiae indicated greater infectious stress among the non-elite, for whom lesion prevalence was 7.14 times greater than it was for elite groups, though small samples of elite bilateral tibiae and the small numbers of affected individuals in older age classes probably inflate this statistic. The prevalence of degenerative joint disease also varied when examined along the lines of

Table 16.2. Odds ratio comparisons of pathological condition prevalence, high-status ethnic Sicán and low-status ethnic Muchik in Middle Sicán society

Pathological condition	Ethnic Sicán present/absent	Ethnic Muchik present/absent	ÔR[a]	Upper 95% CI	Lower 95% CI	χ^2_1
Linear enamel hypoplasias	10/37	63/90	0.15	0.35	0.06	18.11
Porotic hyperostosis	10/37	55/86	0.22	0.51	0.09	10.67
Periostitis	1/22	8/58	0.14	0.88	0.02	4.16
DJD, shoulder	3/33	11/36	0.30	0.86	0.10	3.99
DJD, elbow	1/32	14/40	0.14	0.48	0.04	9.41
DJD, wrist	0/32	1/38	0.79	4.22	0.15	0.06
DJD, hand	0/23	4/30	0.41	1.92	0.09	0.97
DJD, cervical spine	2/34	10/45	0.30	1.01	0.09	3.02
DJD, thoracic spine	5/37	17/40	0.28	0.67	0.12	6.50
DJD, lumbar spine	8/36	17/41	0.26	0.59	0.11	8.51
DJD, hip	2/31	10/32	0.24	0.85	0.07	4.08
DJD, knee	2/30	6/38	0.39	1.53	0.10	1.37
DJD, ankle	5/30	7/38	0.78	2.22	0.27	0.15
DJD, foot	0/22	3/20	0.35	1.88	0.06	1.15

[a]The common odds ratio (ÔR) represents the summary statistic that reflects prevalence differences distributed through classes 1 thru 6. Values equal to or greater than 1.01 represent higher prevalence in the first population or sample (in this case, ethnic Sicán; the prevalence difference is expressed literally in the ÔR). Values equal to or less than 0.99 correspond to a greater prevalence in the second population or sample being compared (in this case, ethnic Muchik; the prevalence is calculated as the inverse of the ÔR when ÔR < 1).

Table 16.3. G-test comparisons of the prevalence of pathological oral conditions, high-status ethnic Sicán and low-status ethnic Muchik in Middle Sicán society

Sicán			Muchik				
Dental caries, anterior teeth[a]							
Age class[b]	$N_{affected}$/total	Crude prev. (%)	Age Class	$N_{affected}$/total	Crude prev. (%)	G[c]	*p*[d]
1	1/100	1.0	1	21/300	6.98	6.43	0.01**
2	2/193	1.03	2	7/135	5.19	4.88	0.03*
3	0/144	0	3	9/163	5.52	11.17	0.0008**
Dental caries, posterior teeth[e]							
1	19/173	10.98	1	68/400	17.0	2.68	0.10
2	24/335	7.16	2	46/259	17.76	12.39	0.0004**
3	3/216	1.39	3	39/253	15.42	27.07	< 0.0001**
Antemortem tooth loss, anterior teeth							
1	1/107	0.93	1	1/301	0.33	0.51	0.48
2	2/212	0.94	2	3/164	1.83	0.53	0.47
3	4/144	2.78	3	16/195	8.21	4.30	0.04*
Antemortem tooth loss, posterior teeth							
1	6/179	3.35	1	3/370	0.81	4.28	0.04*
2	12/335	3.58	2	16/269	5.95	1.71	0.19
3	8/216	3.70	3	72/312	23.01	33.84	< 0.0001**

[a] Anterior teeth are defined as maxillary and mandibular incisors and canines.

[b] Age class 1 = 0–19.9; age class 2 = 20.0–34.9; age class 3 = 35+.

[c] G-value, or maximum likelihood chi-squared value.

[d] *p*, or the probability of G; * = significant at the 0.05 level; ** = significant at the 0.01 level

[e] Posterior teeth are defined as maxillary and mandibular premolars and molars.

elite/non-elite status; commoners had a higher prevalence in every joint system. Statistically significant differences appeared in the non-elite, who were 3.3 times more likely than the elite to exhibit degenerative joint disease in the shoulder, 7.14 times more likely in the elbow, 3.57 times more likely in thoracic vertebrae, 3.84 times more likely in the lumbar vertebrae, and 4.16 times greater in the hip.

Terminal adult stature did not vary meaningfully between elite and non-elite males and females. Although adult elite males were on average taller (161.9 ± 3.417 cm) than non-elite males (158.5 cm ± 3.417 cm) and elite females were also on average taller (156.7 ± 3.816 cm) than non-elite females (152.1 ± 3.816 cm), error ranges overlap in both comparisons and no actual difference is discernible.

The non-elite sample demonstrated a greater prevalence of oral pathological conditions than the elite (Table 16.3). In comparisons across three broadened age classes to allow for valid statistical comparison, the prevalence of dental caries in the anterior and posterior teeth of the non-elite are all significantly greater than they are among the elite, save for one category of subadults for whom prevalence does not vary. Rates of antemortem tooth loss in the anterior dentition did not vary between the two status groups, but older non-elite adults demonstrated a significantly greater magnitude of antemortem tooth loss, especially of posterior teeth.

The genetic structure of the population also differed between the elite and non-elite. The entire Middle Sicán sample appears to have been relatively heterogeneous ($F_{ST} = 0.041$)[1], and very closely mirrors reported values for other pre-Hispanic Andean populations (Nystrom 2006). Residual values, which estimate gene flow, are highly divergent. The non-elite sample exhibits a residual value of +0.711, indicating a relatively greater than average intake of genes from sources outside the sample (the average value was calculated from the *R*-matrix relative to the two groups compared). This magnitude of gene flow is again consistent with other Andean populations. The elite residual value of -6.708 is strongly negative, demonstrating a very significantly lower than average intake of genes from external sources. This is consistent with a highly circumscribed mating network that did not overlap appreciatively with anyone outside the elite social group.

To date, 43 Middle Sicán individuals have yielded amplifiable ancient DNA. While we caution that this is a small sample, notably different proportions between haplogroups A, B, C, D, and Other are currently observed in elite and non-elite Middle Sicán samples (Fig. 16.10). While each group possesses various proportions of each major haplogroup (except for the non-elite, who lack Haplogroup C), the elite are characterized by greater proportions of Haplogroup A and B and the presence of Haplogroup C, while the non-elite possess double the proportion of Haplogroup D and have a sizeable contribution of "Other," which the elite do not possess at all.

Discussion

Human Biocultural Variation during the Middle Sicán Period

Social status on the level of an elite/non-elite distinction appears to strongly correlate to the patterning of biological stress, population structure, and constructed ethnic groups in Middle Sicán society. This statement is not in-

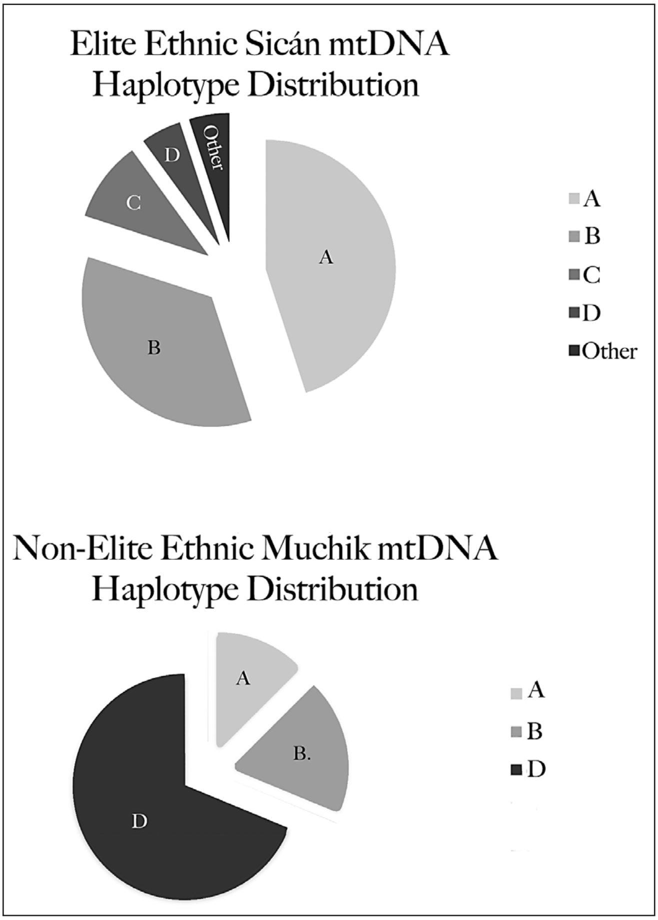

Figure 16.10. Mitochondrial DNA haplogroup distribution among the elite ethnic Sicán and non-elite ethnic Muchik.

tended to promote an underlying ethnic essentialism or to equate identity with an essentialist "ethnic" biology (see Stojanowski 2010 for thoughtful critiques of these views). Rather, the situational cultural constructions of group identity and hierarchy shaped distinct biological outcomes. Many pre-Hispanic north coast societies expressed constructions of institutionalized social inequality. It was even embedded in the mythology of the north and central coasts, where social hierarchy was legitimized as part of the structure of the cosmos itself: early postcontact sources recorded that elite males, elite females, and commoners each were said to have distinct cosmological origins that emerged from different stars or eggs of gold, silver, and copper (Calancha [1638] 1976; Rowe 1948; Rostworowski 1961). A remarkably similar concept is echoed in the circumscribed availability of metals expressed in Middle Sicán mortuary practices.

It should also be noted that the *parcialidad* system of social organization, which lasted from at least Late Moche times (Shimada 1994) to the Early Colonial era, had a number of inbuilt characteristics, supposedly in order to offset inequality. North coast elites were recognized by their subjects as holding power over life and death at the time of Spanish conquest, but their power was proportional to how well they provided for their people (Ramírez 1996). Obligations between rulers and subjects were mutually reinforcing and interdependent. Yet late pre-Hispanic north coast polities were also by nature asymmetrical moieties. Bioarchaeological evidence instead shows that socioeconomic differences between elites and non-elites represent a relative lack of well-being among the ruled. This system did not necessarily mitigate the biological effects of inequality in terms of large-scale asymmetries. It is possible that the appearance of interdependency and conciliatory features in *parcialidad* organization served to downplay or mask social asymmetry (*sensu* Shanks and Tilley 1982) in order to limit the antipathy, social tension, and structural instability that resulted from social asymmetries.

A basic explanatory model (Fig. 16.11) of variations in Middle Sicán biological stress points to access to resources and diet in particular as the lynchpin variable. Oral paleopathological data indicate that the axis of inequality involved superior (or at least adequate) dietary resources for those of elite Sicán status. The ethnic Sicán consumption of starchy carbohydrates appears to have been lower than the inferred significant dietary contribution of such foods among the commoner Muchik (cf. Cutright 2010). So it is possible the ethnic Sicán made up the balance by consuming larger proportions of less cariogenic foods such as terrestrial or marine protein. Dietary protein appears to inhibit dental caries formation (Hillson 2008), and the proportion of dietary carbohydrates in elite Sicán diet may be masked or not accurately reflected in oral paleopathology. Either way, elite status appears to have secured a higher-quality and more nutritious diet. In comparison, empirically worse dental disease among the non-elite Muchik points to a combination of greater proportions of starchy cultigens and less access to protein, even though this group included the fishers and camelid herders who were producing protein resources.

Dietary variation can also explain much about the greater susceptibility of the non-elite Muchik to acute forms of childhood stress that led to the disruption of tooth enamel formation. Nutritional insufficiency in combination with factors such as parasitism, sanitation, infection, and contaminated sources of drinking water (e.g., Kent 1986) also relate to an elevated

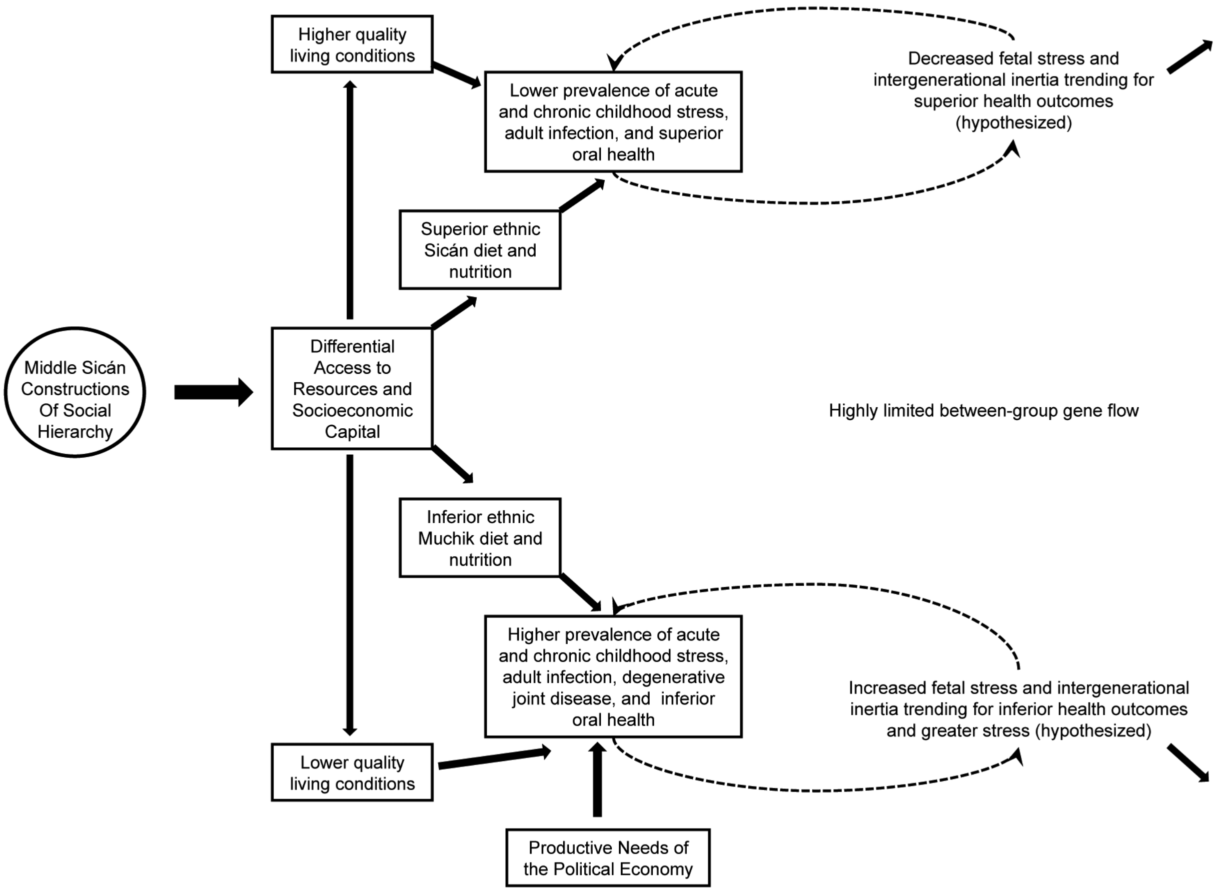

Figure 16.11. A model of the basic causes and effects of divergent Middle Sicán health outcomes, including hypothesized epigenetic elements. Drawing by H. Klaus.

prevalence of chronic childhood stress that is manifested in the skeleton by porotic hyperostosis. Various local settlements were fairly high-density population agglomerations, such as on the north bank of the Lambayeque River and in the Pampa de Chaparrí (Hayashida 2006; Tschauner 2001). Along with crowding and general living conditions, inadequate nutrition affects immunocompetence (Larsen 2015) and is associated with prevalence differences of nonspecific infections. The invariant terminal adult stature we found, however, is not surprising. Stature in coastal Peru appears to have been highly invariant and canalized (Klaus and Tam 2009) and may not be a particularly useful variable except in cases where stress is severe before age two (Floyd and Littleton 2006).

The patterns and relative intensity of habitual physical activity can be cautiously inferred from degenerative joint disease. The non-elite Muchik seem to have engaged in habitual activities that excessively loaded their joints and caused joint injury earlier in life, especially in the use of their upper limbs and hip joints. This would be consistent with evidence that the Muchik were the productive agents of the Middle Sicán economic powerhouse. Conversely, the lifeway of the Sicán elite appears to have not been habitually demanding at all. Again, diet may have also played a synergistic role, as an emerging understanding links inferior diet with a heightened predisposition to degenerative joint disease (Petersen et al. 2010).

The crude prevalence of trauma (not including sacrificial trauma [Klaus 2009]) is so low in elite and non-elite groups that multivariate comparison could not be undertaken, but the pattern is markedly different. Non-elite trauma involves a handful of well-healed broken long bones consistent with activity-related injury and one example each of a healed nasal bone and a zygomatic bone fracture suggestive of interpersonal violence. However, the principal personage of the Huaca Loro East Tomb featured a well-healed parry fracture of the right radius (Yamaguchi 1994). The principal personage of the Huaca Loro West Tomb endured a large, forceful penetrating stab wound to the left ilium (Fig. 16.12). The angle of entry indicates that his bowel and iliacus muscle were punctured. The wound was considerably remodeled, indicating survival after injury. The possible male personage of Trench 1, Burial 4 at Huaca Loro featured an unhealed penetrating cranial fracture posteroinferior to his left parietal boss (Sakaue 2009) that is consistent with a blow delivered from behind. These kinds of injuries show that these robust men had active lifestyles and perhaps were related to some kind of hierarchical competition within and between elite lineages. Also, ethnohistoric sources indicate that if a ruler failed in his duties or obliga-

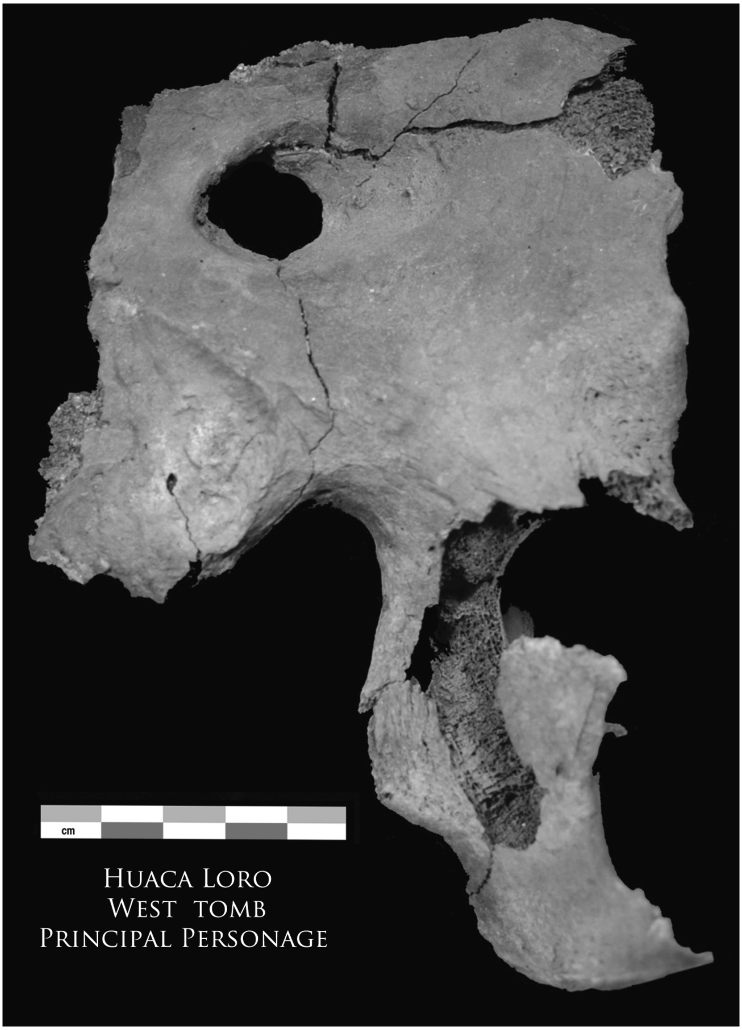

Figure 16.12. The left os coxa of the Huaca Loro West Tomb principal personage exhibiting a well-healed large puncture wound of the ilium. Photo by H. Klaus.

tions, commoners had a right to remove a lord from power by rebellion and murder (Ramírez 1996; Rostworowski 1961). Given the lack of evidence of institutionalized or secular warfare in Middle Sicán society, the quality of violent trauma in these individuals may reflect occupational hazards of elite status that predisposed the elite to violent trauma.

As sample sizes are small, we are just beginning to glimpse regional genetic variability and to understand the evolutionary history of coastal Andean peoples. Both *R*-matrix analysis and mtDNA variation indicate that

the elite Sicán and non-elite Muchik were genetically distinct. One implication of mtDNA variation is that the elite ethnic Sicán, unlike the commoner Muchik, may not have originally been local to the Lambayeque region. The elite display frequencies of Haplogroups A and B, which are more common to the northern Andes and are associated with objects and art styles linked to far northern coastal Peru or southern coastal Ecuador (Shimada 2014a; Shinoda 2014). Also, distinct patterns of mtDNA inheritance and the finding of such strongly negative residuals from the *R*-matrix is consistent with earlier studies of dental trait variation among ethnic Sicán elites that indicate a high degree of relatedness (Corruccini and Shimada 2002) that was driven by traditions of endogamy and patrilocality with very little outside genetic input.

One element of this behavior may have been ideological. Sicán lords likely portrayed themselves as the living personification of the Sicán Deity, an entity that was the intercessor between humans and nature and the source of life and water in the world (Shimada and Samillán 2014). In a society where kinship and descent was extremely important, by "tracing their link to the divine through blood, the Sicán would have made a strong case for religious authority" (Jennings 2008, 186) which would have created a commanding construction of inequality. A second element was no doubt political. Marriage among the elite could have been a form of political protectionism. Widespread intermarriage across ethnic group lines could have threatened the monopoly of the ethnic Sicán on social, economic, and religious power, forcing a broader distribution of kin-based rights among other people such as the local Muchik. In all, it seems that Middle Sicán social hierarchy literally shaped the society's gene pool.

The Bioarchaeology of Hierarchy: Prospects and Cautions

This study of skeletal biology and social inequality in the Middle Sicán culture provides a wider opportunity to consider the role of social, economic, and political theory in bioarchaeology. For example, findings in this chapter can be the first steps in a case study of the phenomenology of "embodiment" (e.g., Krieger 2001, 2004, 2005, 2008) between Middle Sicán elites and non-elites. Such a social epidemiology perspective helps focus problem contexts toward more comprehensive ecosocial thinking and to question how and why unequal patterns of biological stress manifest and persist. Ethnic Sicán and Muchik stress patterns cannot be understood in any other terms outside their social ways of living. Middle Sicán society shaped distinct elite and non-elite "pathways of embodiment," but without

detailed and contextualized archaeological perspectives, interpretations of embodiment are not particularly tenable. Contextualization is fundamental to understandings of how material and social worlds dialectically interacted with biology to reflect social realities in hard tissues. Embodiment is an eminently useful interpretive tool that may lead to exciting new directions in osteological research and interpretation.

This study also leads to thinking about the long-term and large-scale effects of biological inequality. Here, the non-elite occupied the low end of an asymmetric socioeconomic relationship with their rulers and became socially unequal and inherently less healthy. Around AD 1100, the Middle Sicán leadership came to an abrupt end, seemingly at the hands of its populace. Systematic burning of large corporate structures at Sicán suggests a concerted and focused effort to remove what symbolized the elite. While the elite's ancestor temples atop the pyramids and the structures at their bases were intensely torched and abandoned, local communities such as Huaca Arena and Huaca del Pueblo Batán Grande were not affected in any way (Shimada 2000, 2014a). Contributions to the political and religious demise of the Middle Sicán included a multi-decade drought that began around AD 1020, a historic flood caused by a large El Niño event near the end of the drought (AD 1050–1100), and the costly aggrandizement of the elite Sicán ancestor cult largely at the expense of local labor, well-being, and resources (Craig and Shimada 1986; Shimada 2000, 2014a). Undercurrents of resentment, distrust in the elite in the face of a series of natural disasters, and resource pressure may have finally eclipsed the toleration of physical distress, acquiescence with inequality, and productive abilities of the populace. Entanglements between hierarchy and biological stress may sow seeds of sociopolitical instability and political collapse.

One of the other persistent questions we asked ourselves as we conducted the study dealt with the levels of causation of biological stress. Our thinking evolved toward coupling the stress model discussed at the beginning with deeper potential causative factors. Skeletons are not "blank slates" upon which life history is written. Studies of human biology identify organismal and population-level variations in developmental plasticity (Waddington 1957; West-Eberhard 2003) and epigenetic fetal programming of adult biological outcomes, including immune function (Barker 1992; Kuzawa 2008; Kuzawa et al. 2008; Langley-Evans 2004; McDade and Kuzawa 2004; Wintour 2006). In bioarchaeology, the manifestations of stress in bones are almost certain to have some roots in conditions such as maternal behavior, health, and nutrition that impact critical periods during early ontogeny.

Intergenerational inertia (Kuzawa 2008) is a fascinating concept that points to an epigenetic phenomenon in which biological outcomes in one generation can predispose subsequent generations to similar outcomes, thus perpetuating and even potentially deepening the initial biological state. This can be imagined to have been in operation among Middle Sicán peoples: disparity in biological stress patterns could have initiated two mutually exclusive feedback loops powered by the acquisition of socially acquired phenotypes: increased Muchik morbidity may have reinforced or predisposed them greater morbidity for them in later generations while the converse was the case for the Sicán (Fig. 16.10) (Kuzawa 2008, Fig. 18.6).

Yet intergenerational inertia, or any other epigenetic mechanism for that matter, seems to be an incredibly difficult process to observe among ancient skeletons (Klaus 2014b). It is possible to strongly suspect that a factor such as fetal nutrition epigenetically contributes to a disposition toward hypoplasia, the prevalence of anemia, a predilection to faltering growth, and adult periosteal infection, but we do not yet know specifically how. Along these lines, but more accessible and productive, are ideas about how stress in early life shapes later health in terms of the biological damage hypothesis (Armelagos et al. 2009; Clark et al. 1986; Goodman and Armelagos 1988, 1989), models of biological frailty (DeWitte and Wood 2008), and the long-term trade-offs incurred by investment in early-life survival (Temple 2014). At the time of this writing, we have begun work on these questions to stimulate new ways to observe, analyze, and interpret biological stress in skeletal remains and ways that can further our interrogation of how phenotypic plasticity and epigenetic effects on biological stress patterning can or cannot be observed or inferred in skeletal remains (Klaus 2014b).

Because of our continuing effort to establish a representative archaeological sample and a highly detailed archaeological context, the positive correlation of archaeological evidence with biological stress patterns and genetic structure seems to generally reflect a real phenomenon. The osteological paradox (Wood et al. 1992) has many levels of value and needs to be carefully evaluated in settings of rapid biocultural change or settings of fast-acting, high-mortality forms of stress (Cohen and Crane-Kramer 2007; Klaus and Tam 2009). One implication of our findings is that settings of social hierarchy can produce patterns of skeletal biological stress that are fairly direct expressions of population prevalence and that potentially minimize the effects of selective mortality and the hidden heterogeneity in risks. The osteological paradox does not appear to be applicable to the Middle Sicán population as a whole, but its impact on specific or unique burial

contexts or other hierarchical societies must be seriously evaluated on a contextual, case-by-case basis (and see DeWitte and Stojanowski 2015).

Last, we cannot forget that many of the prospects and limitations of the bioarchaeological study of social inequality we discussed above are dependent on ample contextual data and an in-depth understanding of regional historical and social contexts. These can be gained only through a sustained interdisciplinary investigation of multiple settlements of diverse size, nature, and periods, such as the investigation the Sicán Archaeological Project has conducted for over 35 years (Shimada 2014b). Such a well-dated and finely contextualized corpus of archaeological data is fundamental to future advances in bioarchaeology.

Conclusion and Directions for Future Research

Our findings suggest a strongly institutionalized distinction between elites and non-elites that correlates to less biological stress among elites and greater biological stress among non-elites. Discrete differences of genetic structures between the major social strata also suggest that social hierarchy was a structural barrier to gene flow and intermarriage across boundaries of social power. This work helps focus attention on the role of social constructions in shaping access to resources that ultimately played a role in the demise of one of South America's most prominent indigenous societies.

A number of pressing questions and issues must be addressed in future work. We were able to examine the biological consequences of Middle Sicán hierarchy in its most basic dimension as a vertical elite/non-elite dichotomy in terms of macrosocial structure. These limitations highlight the need to: 1) carefully expand sampling of low elite and low commoner funerary contexts; 2) sample high elite funerary contexts from other temple complexes at Sicán, as the current sample is skewed toward individuals of the inferred elite lineage symbolized at Huaca Loro; and 3) begin study of how social strata interacted within horizontal dimensions of gender, age, and occupational hierarchies. The variability among the Huaca Loro elite tombs may provide a first glimpse in the latter direction. Future work will no doubt greatly complicate the current picture. We must be cognizant that the Middle Sicán period involved rapid territorial expansion and rapid growth of sociopolitical and economic power and organizational complexity. This implies fluidity in social organization and indicates that there are inherent inadequacies and missing details in our current model of social and biological differentiation. Group membership and its tangible and in-

tangible markers undoubtedly entailed situational and negotiable dimensions. We expect our biocultural model to evolve as our funerary and bioarchaeological data improve. More important, we must remain vigilant and focus our questions on the ways Middle Sicán hierarchy was contested, manipulated, and dynamic.

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Note

1 The F_{ST} statistic is a well-known and classic measure of genetic diversity in the field of population genetics. Here, F_{ST} is a measure of genetic heterogeneity or microdifferentiation (Blangero 1990). Values can range between 1.0 (no contact between populations and variation is maximized such that allele frequencies are fixed) and 0.0 (gene frequencies between populations are identical and there is no between-group variability). See Klaus (2008) for more details and computational basis.

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17

Bioarchaeology and Social Complexity

Departing Reflections and Future Directions

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This volume represents an initial attempt to bring together a set of bioarchaeological investigations addressing hierarchy and heterarchy in a diverse range of societies and forms of social organization. The majority of the chapters focused on specific geographical and temporal frames. The contributions to this book have a clear bioarchaeological problem-solving orientation that often comes from a bottom-up (rather than a top-down or middle-range) approach. Chapters address either site- or region-specific archaeological questions or seek to clarify the effects of social complexity in a given time or place. An immensity of work has yet to be done on the bioarchaeology of social organization. Such work will be informed by the discovery of new skeletal samples, the applications of new methods, and further maturation of theories and analytical rigor. In these closing comments, we take measure of the contributions, highlight some of the themes and take-away messages that emerge from the chapters, and, perhaps most centrally, offer some closing thoughts on potential next steps in the bioarchaeology of human social organization.

Reflections on the Chapters

The examination of sociopolitical organization in the human past has long been a focus of interpretive paleopathological and bioarchaeological studies (e.g., Cohen 1989; Cohen and Crane-Kramer 2007; Danforth 1999; Larsen 2015). Heterarchy, in contrast, is a concept that has been a part of archaeological studies for only about 30 years (Crumley 1985), and its percolation into bioarchaeological thinking is even more recent. Both

concepts are inextricably involved in shaping sociopolitical variation, but identifying their potentially distinctive effects in the bioarchaeological record is unquestionably challenging. Osteological manifestations of any kind, not just those related to status differences, have a restricted biological phenomenology—that is, they can be seen as phenotypically limited in the types and ranges of expression and frequent nonspecific expression, and are, except for traumatic injury, generally reflective only of chronic forms of biological stress or disease. At the same time, bioarchaeological science has learned to harness these same "limiting" characteristics and turn them into analytical strengths. Just as the human skeleton offers an imperfect form of knowledge about past social organization, it offers many unique and powerful lines of data that are unavailable elsewhere in the archaeological record. Because these skeletal phenomena are rooted in rather deeply embedded or embodied biological responses, beginning on a genetic/cellular/hormonal axis, they are generally beyond the control of an ancient culture to symbolically manipulate or misrepresent.

One of the principal points this book drives home is that the bioarchaeology of social organization must involve both the contextualization or integration of skeletal observations with archaeological data and the use of multiple, independent lines of information. Through this methodology, it can become possible to demonstrate that it is difficult for a stratified society to hide the differential effects of skeletal trauma on different social strata (Harrod et al. this volume). Similarly, enamel hypoplasias might be ultimately interpreted as stemming from social discourses involving power and resource access, as their manifestations tend not to be a manipulated discourse in antiquity, as are other, more fluid forms of material culture, body modification, or mortuary ritual. Several chapters in the book make this point, especially Cook and co-authors. Thus, when all sources of information are combined, a potentially powerful and objective perspective can emerge.

Since the bioarchaeology of ancient hierarchical social organization is a more directly testable concept that is potentially less ambiguous in the archaeological record, most of the studies in this volume focused primarily on this issue. Most authors incorporated an implicit understanding of hierarchy as reflected in broadly accepted archaeological indicators, including variation in area of disposal (village/mound, center/satellite), type of grave (tomb, cyst, or pit), and number and type of grave goods. Klaus and colleagues were fortunate to have a more unusual marker available in their study: rather rigid associations of certain metals with specific genders and

social strata in northern Peru. In many of the studies, especially those of Old World populations, historical information gleaned from oral traditions, written documents, and artwork was invaluable helps in generating hypotheses about possible status distinctions in the burial assemblage, although Schepartz and colleagues astutely noted that this approach overtly distorted the record at times in their investigation. Robbins Schug was the only author who attempted to explicitly define hierarchy in a detailed theoretical sense; she considered hierarchy to involve dimensions of exclusion from power.

The osteological phenomenon used to test status differences in the bioarchaeological assemblage varied widely across chapters. The first three chapters in Part I examined the skeletal evidence of growth and adult stature, which are established windows on socioeconomic status and social structure (Bogin 1999). Boix and Rosenbluth looked at skeletal data on the largest spatial and temporal scales seen in this book; they considered sweeping, big-picture, cross-cultural questions. They highlighted several interesting methods for bioarchaeologists, including the Kuznets curve and concepts of labor mobility. Their diverse data sets also emphasized how strongly hierarchical sedentary agricultural systems unequally distribute resources, the biological reflections of serfdom and absolutism, the bargaining versus efficiency hypothesis for variation in human sexual dimorphism, and the effects of the transition to industrial economies. As economists with a different disciplinary approach, Boix and Rosenbluth's chapter is replete with thought-provoking hypotheses for bioarchaeologists. Testing the broad, cross-cultural, and cross-contextual applicability of their models will provide important new studies of stature, variations in limb proportions, growth plasticity, and how economic factors affect ecogeographic variation in body form. In addition, we think that broader concepts involving the nature of coercive political machinery, storable assets, patriarchy, and military technology that Boix and Rosenbluth articulated need not be tethered exclusively to studies of stature; they can also be useful in assessments of other bioarchaeological phenomena.

Elements of the Classic Maya civilization were quite likely hierarchical, as various forms of evidence attest. Wright and Vásquez's revisitation of Haviland's classic study of stature among the Classic Maya at Tikal is timely indeed. Following many years of archaeological study and the emergence of new skeletal samples, they refined the procedures by which stature was calculated, including use of partial long-bone elements and the applica-

tion of greater statistical rigor. While the authors encountered evidence that occupants of Tikal lived in a hierarchical society with unequal access to nutritional resources, they also indicate that stature data may not be the most sensitive biological reflection of hierarchy at this site. Nitrogen isotope analysis suggests stunted growth that is invisible in the osteological evidence. This difference in diet and in methodological approach is an area that is ripe for further consideration of possible heterarchies as well.

Becker's contextual and osteobiographically minded study of stature outcomes in two members of the early royalty of the emergent ninth-century Bohemian state offered various intriguing points. While the prince and his wife were among the taller members of those buried in an elite area of the church, they were clearly not the tallest. Some kind of privileged status or at least a divergent set of life experiences from other people might be seen in their notable robusticity and in the fact that resources allowing for survival followed the prince's suspected trephination—a notable fact given the rates of surgical success in ninth-century Europe.

Chapters by Wright and Vásquez and by Becker allow us to derive a few key points about stature. First, they should not be taken as casting aspersion on the idea of relationships between social status and stature. Such data are very well established, in ways that range from how those working in the field of human biology understand environmental effects on growth at the cellular level to how social and health theorists interpret the data that demonstrate the collisions between social inequality and nutritional resources. Instead, for us, these two chapters provide excellent examples, on different scales, of how the puzzle pieces might not fit broader and well-established explanations. They demonstrate times and places when the relationship between stature and social status may be complicated by numerous mediating factors. Their work also brings us back to points Floyd and Littleton (2006) and Stinson (2012) raised about the timing of biological stress and the plasticity of human growth. Stature, in some respects, probably represents a highly canalized trait for which the final phenotypic outcome is difficult to perturb. That is, the stressors that typically produce permanently stunted growth are those that are severe, of long duration, or that occur during a critical period of growth very early in life. As Floyd and Littleton (2006) demonstrated, systemic stress during the first two years of life is most likely to produce permanent growth deficits. Growth stunting that takes place after the close of this critical period will probably be erased if the individual is given a chance to catch up on growth later in ontogeny (Stinson 2013).

This clearly indicates that the search for relationships between stature and social structure may be closely anchored to what takes place in early childhood. Could this be another complicating factor in how we interpret stature variation (or the lack thereof)? Does shorter adult stature most directly represent an effect of early life stress? Does a lack of stature variation across archaeologically defined social strata (i.e., Klaus, Shimada et al., this volume) indicate that nutritional resources were distributed equitably or the presence of cultural buffering systems that distributed biological stress into later childhood and that the effects of the early stress eventually became invisible in cross-sectional skeletal assemblages? Integration of childhood growth velocity data (Klaus and Tam 2009), longitudinal isotopic data, nitrogen isotope data, and other independent lines of paleopathological evidence (i.e., enamel defects, anemia, and other metabolic bone diseases) may develop ways forward.

Ranked social systems seem to involve asymmetrical constructions of gender. The chapters in Part II provide direction for thought on gender and the bioarchaeology of social complexity through snapshots of gender constructions and the consequences of inequality in three ancient societies. Zakrzewski's investigation started out as a broadly conceived study of how gross skeletal morphology may reveal social structures in the state-level societies of ancient Egypt. Her findings point to constructions of gender inequality, especially by the time of the Late Predynastic era, when the most rapid and intense developments of social ranking and hierarchy are hypothesized to have occurred. Zakrzewski could only draw on less-than-ideal skeletal samples, as they were relatively small, scattered, and poorly contextualized. Much to her credit, she was still able to derive a range of tantalizing observations that provide new hypotheses for the bioarchaeology of Egypt and beyond.

Schepartz and colleagues also found evidence of gendered differences in their evaluation of biological stress and diet in Late Bronze Age Greece. Their analysis is informed by Mycenaean material culture, artistic depictions, and written records that describe emic constructions of genders, including distinctive assignments of tasks and privileges. In other accounts, women are mentioned mainly as "slaves," although the exact meaning of the word is unclear. Paleopathological and stable isotope data appear to reveal evidence of intertwined hierarchies of gender and social class, especially among women. The authors argue that greater access to protein, which is supported by isotopic analysis, seems to have been a key factor

that differentiates male oral health from that of females and that gender-related differences, possibly related to food preparation activities, appear to provide a more robust pattern of differentially embodied experiences than notions based on a straightforward model of vertical hierarchy.

Similarly, Pechenkina and colleagues undertook a diachronic and comparative examination of skeletal stress markers, oral health, and mortuary patterns between a Neolithic and a Bronze Age site in Henan Province, China. In their selection of skeletal traits, they distinguish between skeletal conditions that reflect growth and development in childhood and those that progress with age. Although the patterns they observed among the health markers are highly varied and a few class-based associations emerge in the Bronze Age Xiyasi individuals, gender-based differences seem to cross-cut the data sets.

These three chapters are important in incorporating challenging issues such as conceptions of gender and heterarchy into the bioarchaeology of social complexity. In part because of its strongly empirical and cultural ecological roots, bioarchaeology has sometimes resisted connections between skeletal data and gender theory. Past engagements with sex and gender have been critiqued as only scratching the surface of a much deeper productive engagement (e.g., Geller 2008; Sofaer 2013). As the social bioarchaeology approach grows, we need to continue to problematize just how to discover the connections between biological sex and ancient constructions of gender, dynamic sexualities, and the biological and the inherent social plasticity of gendered bodies. The possibilities seem almost endless, and we recommend that bioarchaeologists (regardless of whether their research foci are evolutionary or social in scope) carefully study the chapters in *A Companion to Gender in Prehistory* (Bolger 2013). To us, the cross-disciplinary value of such thinking is of immediate intellectual value and demonstrates that much of the work being done in the bioarchaeology of gender will need to continue to mature and become increasing sophisticated if it is to be considered on par with that of our archaeological colleagues. It is likely that these are steps that will take the discipline closer to concepts of the embodiment of social realities and personhood. A gendered approach of the bioarchaeology of social hierarchy might also provide an opportunity to get into people's heads' so to speak. It is possible to carefully consider a bioarchaeology of ideology and cognition from this point of view—one in which there may be ways of assessing ephemeral and abstract concepts about the invented, differential value statements assigned to some

people's lives or personhoods. In this way, the performances of biological variation shaped by gender in the past may unlock additional perspectives on inequality that might not be readily apparent.

Part III dove into comparisons of social structure, inequality, and skeletal variation. In their study of an early state in Europe, Jiménez-Brobeil and colleagues examined a skeletal sample from the El Argar population of Bronze Age Spain. This society expressed relatively self-evident forms of hierarchical expressions of material culture that included sex- and class-based use of grave goods. The authors observed differences in most of the markers they evaluated, but they could not identify a consistent pattern that helps refine our understanding of the nature of the hierarchy. Tritsaroli, who described the results of research at the Pigi Athinas site in Greece, suggest that the simple burial practices without any strict differentiation indicate that interments were organized by kinship ties in the Middle Helladic period (2050/2000–1680 BC). By the Late Helladic I period (1680/1600–1580 BC), social differentiation along the lines of gender and age differences were becoming more pronounced and asymmetrical. As with many of the studies in the volume, few consistent skeletal patterns emerged in the analysis of this sample, perhaps because stark differences in power were still emergent and coalescing in this early complex society.

In the most overt test of hierarchy and heterarchy, which do not have to be mutually exclusive, Robbins Schug explored the biological evidence of social and political organization in the Indus Valley civilization. Archaeologists have at different times posited that both systems of status distinction characterized Harappan culture. Thus, skeletal evidence offers a unique and wholly independent source of data for exploring such questions. Robbins Schug argued that gendered and spatial differences in patterns of biological stress, specific infectious diseases, and mortuary treatment fail to meet the expectations of a heterarchical society or egalitarian social relationships. This work is a key contribution to the fascinating and vital debate about the nature of Indus social organization.

Cook and colleagues synthesized a broad range of observations regarding the osteological and archaeological evidence of hierarchy in the Hopewell culture. They synthesize evidence accrued from over 40 years of bioarchaeological investigations that points toward the near-certainty that forms of hierarchy, including ascribed status, were indeed present in the Woodland period of the Lower Illinois Valley. One major element in their chapter, however, concerned the friction between hierarchical and

heterarchical explanations of Hopewell culture. To us, this issue reflects some of the broader tensions that exist between archaeologists and physical anthropologists and between empirical/processual and interpretive/post-processual approaches. Cook and colleagues suggested that archaeological thinking on Hopewell social organization is out of balance. Paralleling one of Robbins Shug's messages, these authors demonstrate that empirical evidence consistent with hierarchy is impossible to dismiss in light of what the extensive osteological evidence offers to such debates.

Chapters by Betsinger and Ross-Stallings parallel one another in interesting ways. They both explore hierarchy among what are traditionally considered chiefdoms in the prehistoric southeastern United States. Betsinger's study of two ranked Mississippian communities in eastern Tennessee showed that at both locations, those buried at the mound center appeared to be elites, while those interred in the village were considered to be of lower status. In all skeletal measures of stress, elites displayed lower frequencies of pathological conditions, and many of the differences demonstrated strong degrees of statistical significance. Most of the advantages apparently embodied by the elites are interpreted in terms of access to a better diet, especially protein resources, a conclusion that runs through many of the studies in the volume. Betsinger also note that burial patterns appear to be gendered; males were typically interred in mounds and females were buried in the village. This suggests that men may have had more power than women or that males and females may have controlled different spheres of activity in a kind of heterarchy. Further exploration of this possibility may lead to promising analysis.

Ross-Stallings also compared evidence of biological stress and diet in two hierarchically ranked sites in the late prehistoric Mississippi Delta. One of the sites is a mound center marked by a public space and monumental architecture, and the other was one of its satellite villages that presumably provided foodstuffs, goods, and labor to the elite. Though the skeletal samples were admittedly small, she observed evidence of an inferred overall pattern of better nutrition and less stress at the mound center. The possibility that developmental defects of the sacrum were related to foliate deficiency was also quite interesting. Ross-Stallings suggested that the satellite villagers show greater stress in part because they were locked into patronage relationships with the centers, which siphoned off essential resources. Such a pattern has not been previously evident in other chiefdoms in the prehistoric southeastern United States, however. In those settings, it ap-

pears that smaller, more outlying sites had more direct access to resources and enjoyed greater distance from centers of disease (Danforth et al. 2007). Ross-Stallings's findings could reflect a more regional development during the Late Mississippian period.

Harrod and colleagues examined violence as a reflection of patterns of hierarchy in the pre-contact American Southwest. The study contrasts findings from two elaborate burials at Chaco Canyon (which represent one end of the social spectrum, as these individuals were posited to represent high-status members of the community such as political leaders, priests, or warriors) with findings from the skeletal remains of women from the La Plata River Valley (who represent the opposite end of the social spectrum, as they were probably slaves captured through raiding activities). The authors suggested that as hierarchy emerged, there was an increase in interpersonal and intergroup conflict and in socially sanctioned and ceremonial ritual violence, especially during times of environmental degradation, food shortage, and drought in the unstable climate that characterized the region. The primary focus of the chapter involved how skeletal traumas reflect social inequalities. Other pathological conditions investigated in this chapter, which include terminal adult stature, anemia, infection, activity markers, and diet, also positively correlated with social class. Harrod and co-authors argued that under such challenging environmental circumstances, violence should not be thought of as aberrant behavior, but instead as highly structured, often ritualized activities that functioned as a kind of problem-solving strategy.

The final two chapters in the volume explore social organization in Central and South America. Storey and colleagues examined how biological stress related to urban settlement patterns and social structures in an intricate set of comparisons at two major Classic period centers in Mesoamerica, Teotihuacán and Monte Alban. At these sites, adults of the higher-status compounds appeared to have had better long-term survival following stress events as children. Lower-status adults experienced and survived often multiple forms of biological disruption and stress before their death and perhaps an elevated susceptibility to later infection and disease. The contribution of Storey and colleagues is unique in this volume in that they did consider their results in terms of the osteological paradox (Wood et al. 1992). Such an approach stimulates continued bioarchaeological attempts to determine when an absence of pathological change in bone represents hidden heterogeneity in frailty and when it indicates a lack of biological stress. They also emphasized that urban living may have posed

challenges to health and well-being that sometimes cross-cut social strata distinctions.

Klaus and colleagues assessed biological correlates of hierarchy in the late pre-Hispanic Middle Sicán theocratic state of the Lambayeque Valley of northern Peru. One sample consisted of members of an elite ethnic group called the Sicán. These people ruled over a low-status population, many of whom were members of a Muchik ethnic group. Variation of mtDNA haplotypes and inherited tooth size suggests that the nobility constituted a separate breeding group from the commoners. This finding is unique among the various populations under study in this volume. Virtually all skeletal indicators of biological stress, diet, and lifestyle pointed to strong tendencies of class-based differences, namely that the elite enjoyed a more privileged lifestyle. Though these findings are from a very different scale and structure of society, they parallel those Betsinger reported in Mississippian-era Tennessee.

The work in Part III in some ways could be described as reflecting mainstream contemporary bioarchaeology in that it largely employed the standard battery of bioarchaeological indicators, including varying levels of skeletal lesions, isotopes, and ancient molecules. It is hard to imagine a time in the future when enamel hypoplasias or skeletal trauma, for example, will not be relevant to the study of ancient human biology. The bioarchaeology of social complexity can be an analytical path that will encourage new forms of study and guard against descriptive work drawn from a recitation of methods. This is another reminder for us to internalize self-critical reflections involving sampling design, methods, and interpretations. In addition, roadmaps are currently developing that provide ways to transcend descriptive studies of the frequencies of skeletal lesions. Connections between pathological conditions, such as the effects of early life stress on later patterns of frailty, morbidity, mortality, phenotypic plasticity, the human microbiome, and epigenetics, hold particular promise for developing an understanding of fundamentally powerful mechanisms in human biology (Armelagos et al. 2009; DeWitte and Wood 2008; Klaus 2014; Temple 2014). These approaches have a vast and as-yet-untapped potential in the skeletal studies of social complexity.

A recent article by Temple and Goodman (2014) provides much impetus for discussion. They convincingly argue that bioarchaeology "has a health problem," in that we are not measuring health at all and that we have been grossly misusing the term. Instead, they argue, skeletons give us reflections of biological and physiological stress—products of typically long-term and

chronically disrupted allostatic loads on biological systems. Far more than a challenge to terminology, their reflexive analysis is a potential turning point in how our discipline conceives of and operationalizes our subject matter. In addition, any reasonably thorough reading of the archaeological literature on the material cultures of developing and established complex societies might be a bit jarring for a social bioarchaeologist. Archaeologists have been working on issues of social complexity longer than we have, and it shows in their greater depth of theorization and greater sophistication in the use of analogy, model building, critical approaches to comparative studies, and so forth (e.g., Bogucki 1999; Johnson and Earle 1987; Smith 2012; Yoffee 2005). Yet meaningful understandings derived from human skeletal biology are surprisingly absent in such works. This is to say that archaeologists and bioarchaeologists need each other to advance the future of the theme of social organization and inequality in social science research.

Themes, Issues, and Future Directions in the Bioarchaeology of Social Complexity

Seven broad observations can be culled from the data the studies in this volume provide.

1. In both inter- and intra-site comparisons, evidence of both heterarchy and hierarchy is plentiful in material cultural terms, primarily defined by grave goods, burial treatment, and site architecture. Systematic indications of inequality in biological terms are less clearly patterned, suggesting less direct correlation of status and health than might be expected. Some of this may have to do with sampling designs, sample sizes, and the vagaries of preservation. In other cases, the emergent or incipient nature of hierarchical social organization is probably being perceived (especially in the studies by Jiménez-Brobeil et al., Becker, and Tritsaroli). Still, the chapters together generally demonstrate a trend toward greater expressions of morbidity or biological stress in inferred lower-status groups. This would be the expectation of a "direct" or literal/representative reading of the skeletal evidence (where lesion count is proportional to biological stress) and thus they run contrary to a straightforward application of the osteological paradox.

Most of the differences observed in the various investigations were also interpreted to make sense in terms of hierarchical social organization. Often, contextual information from archaeology, ethnohistory, or documen-

tary sources helps justify these kinds of interpretations. At the same time, we might suspect that complex heterarchies also co-existed with these hierarchies but are akin to specters lurking in the shadows, just beyond the reach of our data or methods. Although heterarchies are inherently more challenging and ambiguous, uncovering them requires greater-than-average contextualization and lines of supporting archaeological data. Heterarchy is a topic that represents a vital frontier for future work.

Sample size is a perennial concern. Many authors, including Becker, Zakrzewski, and Ross-Stallings, acknowledged and attempted to adjust for small sample size issues in their studies. They were very clear that the patterns they observed in the data are tentative. Even with the initially large sample size that Betsinger worked with, the final comparative samples became much smaller with breakdowns by age, sex, and social status. Examination of potential heterarchy can add even more categories, such as priests in the elite group, thereby decreasing the sample sizes available yet further. When statistical testing is not feasible, contextual and qualitative approaches must come to the forefront, as Becker emphasized.

Larger sample sizes can of course encourage the empirical evaluation of findings. Quantitative variation is a core element of analysis in a number of the studies in this volume, including those of Klaus and colleagues, Storey and colleagues, Pechenkina and colleagues, and Betsinger. However, application of statistical methods often can involve collapsing categories in order to achieve sufficient sample size. Furthermore, while it is encouraging that a few chapters employed more sophisticated paleoepidemiological tools (Klaus 2014) such as odds ratios, the technique requires the reduction of data and comparative categories into binary dichotomies. We wonder to what degree such procedures overlook some of the subtler social variations, including heterarchical differences. Although many, if not most, nonsignificant differences in levels of biological stress markers between groups are likely the effects of random variation, they cannot be summarily dismissed as observations without meaning. Instead, these differences need to be further corroborated with evidence from archaeology, history, and other cultural markers if they are to be interpreted as meaningful evidence of absence.

Ultimately, these dimensions of the volume hopefully drive home the point that the bioarchaeology of social complexity and inequality, or any other topic, is dependent on ample archaeological data and in-depth understandings of the regional historical and social contexts. The bioarchae-

ology of social complexity thus holds much promise as an expression of contextual and social bioarchaeology (Agarwal and Glencross 2009).

2. Although one section of the book is explicitly dedicated to sex and gender, this aspect of human social organization crosscuts almost all of the work in this book in one way or another. This is not at all surprising. Sex is arguably the aspect of a biological profile that can be assessed most reliably and with the least amount of a skeleton intact (Buikstra and Ubelaker 1994), and of course, virtually every human culture exhibits behavioral distinctions based on their particular and mutable creations of gender. The majority of the chapters addressed sex and gender distinctions, and when differences were found, males appeared to have enjoyed better health, especially according to dietary indicators. Zakrzewski found that stress among females in the lower classes appeared to increase proportionately with sociopolitical complexity. To us, this is a strong association with (or an indictment of) of the varying cross-cultural expressions of inequality that different forms of patriarchy and its associated economic behaviors produce from the household level on up (Boix and Rosenbluth this volume).

Analysis of cultural variables reinforced the presence of inferred gender distinctions associated with status. In most of the studies, both sexes were present in the respective burial contexts. Storey and colleagues observed that males appeared to have continued to receive preferential treatment in the various compounds of Teotihuacán regardless of social class. Yet, interestingly, Pechenkina and colleagues report that females in their study of the earlier sample from China had more elaborate graves than their male counterparts. In one of the more unusual cultural distinctions by sex or gender, Klaus, Shimada, and co-workers noted that Sicán elite men and women were each associated with a different mythic origin and type of precious metal in their burials (gold and silver, respectively), in contrast to the lower-class Muchik population, for whom both sexes were either associated with metal objects made from only from bronze or had no metal items at all.

3. Hierarchical and heterarchical patterns seen in the various studies show differences in long-term patterns of physical activity. Once again, the results generally followed expectations: the lower classes evidenced higher levels of degenerative joint disease, as may be seen in the chapters of Jimenez-Brobeil and colleagues, Klaus, Shimada, and colleagues, Robbins Schug, and Pechenkina and colleagues. These are all consistent with the interpretations that these individuals differentially endured more re-

petitive and stressful biomechanical activities (presumably associated with labor) during their lifetimes. Harrod and colleagues were the most direct in addressing skeletal trauma and hierarchy, as their data allow them to draw stunning contrasts between people at the opposite ends of a hierarchical system. Both Klaus and colleagues and Pechenkina and colleagues noted more fractures in their lower class samples, but in late pre-Hispanic Peru, fractures among the elite were more likely to be related to interpersonal violence, whereas fractures seen in the commoners were more consistent with labor and accidents. Such variation is worth further exploration.

4. The osteological paradox (Wood et al. 1992; also DeWitte and Stojanowski 2015) weaves in and out of the investigations whether various authors acknowledge it or not. A distinction is made clearly in some chapters, especially in the work of Pechenkina and colleagues and Klaus, Shimada, and colleagues, between skeletal lesions that represent developmental stress (e.g., anemia and enamel hypoplasia) and adult patterns of stress (e.g., infection, trauma, and degenerative joint disease). Such partitioning indirectly helps focus the study of biological stress and the potential selectivity of such stress in terms of separate phases of life history. Storey and colleagues raise valuable questions about the relative absence of pathological conditions among some subadults when compared to developmental stress indicators preserved in adult skeletons. This conspicuous absence could mean that elevated subadult frailty was at play and that rapid death drove such a pattern.

However, it is equally difficult to dispute the general pattern that is seen in most other studies in this book: relatively predicable and ostensibly nonparadoxical interpretations emerge from the synthesis of archaeological data of social structure and the distributions of biological stress, diet, and other factors. These range from weak to strong correlations. Cases such as the one Betsinger and Klaus, Shimada, and colleagues present, however, show a positive correlation between childhood and adult stress indicators along lines of social status. A direct reading of lesion frequencies seems appropriate in such cases and is probably generally reflective of ancient biocultural realities, but this can be argued only when the skeletal data are contextualized within the larger world of independent archaeological data. In our opinion, an unresolved question that needs to be a focus of future research involves whether or not actual differences in the morbidity, survival, or frailty of subadults in different populations were at play. We concur with DeWitte and Stojanowki (2015) that local contextualized perspectives,

a nuanced bioarchaeology of subadults, better linkages between biological stress markers and demographic data, and a grounding in pathophysiology will contribute to the further maturation of bioarchaeological interpretations, especially those involving the dynamics of ancient hierarchies and heterarchies.

5. All the studies in this book engage with mortuary archaeology in one way or another. In most cases, investigators measure skeletal variation as a line of contextual information to evaluate health markers or as an independently established reflection of social structure burial patterns. We hope that this will not encourage the use of mortuary archaeology as a kind of middle-range theory in the bioarchaeology of social complexity. Instead, many of the societies highlighted in this book appear to have incorporated diverse kinds of messages about their social structures into their burial patterns. This suggests that we should pay deeper attention to these rituals. Most of the authors interpret variations in mortuary patterns to be a relatively direct reflection of social realities in line with the revised Saxe-Binford, or representationist, school of thought (see Brown 1995). In contrast, Robbins Schug shows the promise of a bioarchaeological analysis of burial patterns outside the comfort zone of the representationalist approach. Skeletal data thus shines as an independent means by which to assess social organization in a society that obfuscated or manipulated social structural symbolisms in funerary practices.

Given the many other avenues and orientations in mortuary archaeology (e.g., Tarlow and Stutz 2013), there are future opportunities and thematic directions to take in the integrated study of burial patterns and skeletal biology in complex societies. Given the various calls for greater integration of mortuary archaeology and bioarchaeology since Buikstra's (1977) original outline of the discipline, the varying levels of integration with funerary archaeology in many of the chapters is encouraging and stimulating. This also suggests that the bioarchaeology of social complexity is best approached through the integration of many different lines of evidence.

6. Hunter-gatherers are complex people, too. When Mark Cohen originally cast a net far and wide in the search for authors for this volume, enthusiastic responses came from those working in settings of appreciable social complexity. The table of contents rather organically began to assemble itself and the subject matter gravitated toward larger-scale cultural phenomenon. Perhaps one of the greatest deficiencies of our volume is the fact that hunter-gatherer societies are unrepresented in the book. This may very much be a reflection of how archaeologists generally tend to think about

social complexity (Hayden 2014). That is, there is a broad supposition that hunters and foragers are simplistically organized, economically humble, and monolithically egalitarian to the point of inevitable bioarchaeological homogeneity—such that any skeletal variation among hunter-gatherers is driven by either ecogeographic or innate biological factors. Such thinking is incongruous with current understandings, especially that of complex hunter-gatherers (see chapters in Cummings et al. 2014).

Though the scales of complexity are clearly different, hunters and gatherers featured their own particular forms of inequalities, internal asymmetries, extensive behavioral flexibility, and other forms of dynamism. Archaeologically tangible complexity began probably around 40,000 years ago and truly took off some 30,000 years later. Hunter-gatherer lifestyles—the very embodiment of human social organization for the vast majority of all history—need to occupy a far more prominent seat at the bioarchaeological table of complexity. A book like this only scratches the surface in terms of reconstructing the biocultural histories of social complexity. In doing so, it gives us indications of the ways our work is cut out for us. Theoretically, this issue represents an important opportunity to reflexively and critically reevaluate just exactly what we are talking about when we use the term "complexity" (see Hayden 2014).

7. Perhaps most important, and to come full circle back to the first of these seven points, the chapters in this book fail to find a single, consistent, predictive, or overarching relationship between social structure and biological outcomes. This no doubt is partially the result of the vagaries of most archaeological and osteological data sets. The different scales of investigation and varying methods no doubt influence this perception as well. What remains, then, still points to an enormous range of variation—whether looking at a synchronic portrait of a site or area or a diachronic regional sequence. Patterns of culture, archaeological data, and human biology perhaps confound simple evolutionary typological definitions of emergent stratification and statehood (e.g., Fried 1967). While trends may emerge in the bioarchaeology of hierarchy involving the generally better health of highly ranked individuals in complex societies, this should never be taken as a given. In other words, while most chapters find evidence of socially structured health variation, the patterns, processes, timing, and consequences of these biological effects appear quite diverse in the ways they emerged and shaped peoples' lives. This reinforces a notion touched upon in Chapter 1: it is productive to be in a de facto state of wariness regarding the potential shortcomings of typological thinking or simplistic

expectations of ancient health. At the end of the day, such organizational schema may be useful, but they must be evaluated with great care and critical outlook and context-embedded, flexible, and particularistic perspectives must be fostered. In light of this, we encourage future bioarchaeological studies of social organization to actively seek out cases where the puzzle pieces might not neatly fit into a top-down approach to social complexity. These exceptions to the broader patterns may contain some of the most revealing data about human social structures and inequality.

For obvious reasons, it is difficult to provide a simple blanket summation of these chapters because of the range of regions, time sequences, and problems they address and the methods they apply. None of the chapters includes the full range of the possible variables or techniques listed in the introduction. The value of the volume, we hope, lies in the range of research issues the chapters juxtapose in the worldwide sample provided, in the variety of skeletal biological data that is analyzed here, and in the different snapshots of the sequence of emerging or established forms of social complexity. It is also worth considering that the book contains perspectives from a rarely seen assemblage of data and methods drawn from three different kinds of archaeology: prehistoric, classical, and historic. It also represents initial, tentative efforts to consider heterarchy in the bioarchaeological record. We hope that these examples will encourage greater consideration of the role of hierarchy and heterarchy in future bioarchaeological research as we seek to better develop a more humanized, more accurate, and more inclusive reconstruction of the nature and scale of social differentiation in the human past.

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